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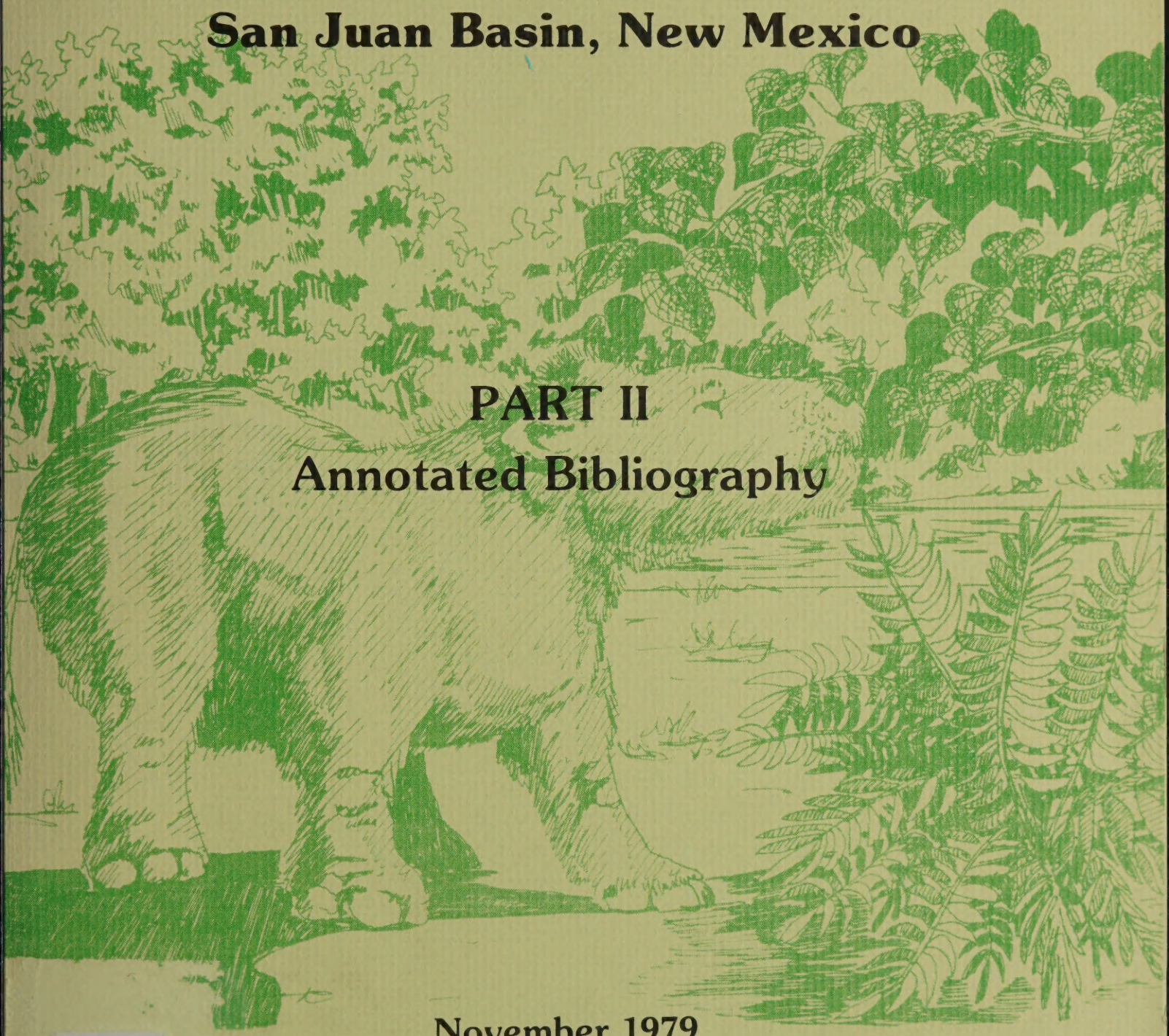
Paleontological Mitigation Study for Coal Lands in the San Juan Basin, New Mexico



PART II
Annotated Bibliography

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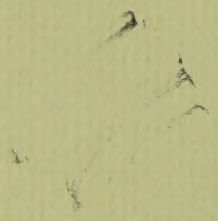

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BIBLIOGRAPHY OF PALEONTOLOGICAL TECHNIQUES AND THE PALEONTOLOGY OF THE SAN JUAN BASIN

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ABBOTT, M. L., 1950.
A Paleobotanical transfer method.
Jour. Paleont. 24:619-621.

A simple method for stripping entire carbonized compression from shale or clay is presented. This method allows for the study of not only the gross outline of carbonized foliage and venation, but the epidermal regions as well.

ABBOTT, R. E. AND M. ABBOTT, 1952.
A simple paleobotanical transfer technique.
Ohio Jour. Sci. 52:258-260.

The authors developed a method of removing entire cuticles of leaf compressions from shale. They mentioned a high percentage of success, thus yielding many excellent specimens from the process. Their method utilizes very cheap, colorless, fingernail polish.

ALVAREZ, W. et al., 1979
Comments and replies on biostratigraphy and magnetostratigraphy of Paleocene terrestrial deposits, San Juan Basin, New Mexico.
Geology 7:66-71. 2 figures.

This forum-type article contains comments by Alvarez and others on possible errors in interpretation on the magnetostratigraphy of Upper Cretaceous and Lower Paleocene deposits of the San Juan Basin made by Lindsay and others. The latter authors replied to these criticisms. Most of the debate centered on whether one or more polarity zones are missing near the Cretaceous - Tertiary boundary. Lindsay et al. stated that an unconformity does exist within the Ojo Alamo Sandstone, but that the represented hiatus is not sufficient to account for a magnetic polarity interval. Those criticizing this interpretation consider a magnetic polarity interval or intervals are missing at the Cretaceous - Tertiary

boundary in the Basin. The fossil record as it pertains to this problem was also discussed.

ALVIN, K. L. AND M. D. MUIR, 1969
Scanning electron microscopy, a new method of studying lignite.
Rev. Palaeob. Palyn. 9:115-118, 1 plate.

The study of lignite has been previously neglected because of difficult and time consuming preparation methods. Mineralized specimens cause serious problems; however, preparation for scanning microscopy has proved to be easy, and the results obtained excellent.

ANTIA, D. D. J., 1977.
A comparison of diversity and trophic nuclei of live and dead molluscan faunas from the Essex Chenier Plain, England.
Paleobiology 3:404-414. 3 Figures, 3 Tables.

Author's Abstract

The rarefaction graphs and trophic nuclei of dead molluscan shell cumulates and their associated live molluscan fauna from seven 'ecological' habitats in Essex Chenier Plain facies are examined and compared. The results show that while the trophic nuclei of the live and dead faunas tend to be dissimilar, the rarefaction graphs indicate that the dead fauna will be more diverse than the live, though changes in the diversity of the live fauna tend to be mirrored in the dead fauna.

AUFFENBERG, W., 1967.
What is a plaster jacket?
Plaster Jacket 6:1-7. 12 Figures.

This article explained the need for using plaster jackets in removing vertebrate fossils from encasing deposits. It also gives a series of diagrams and explanations about proper techniques. Some variation of procedure was presented to accomodate different sizes of fossils and different field conditions.

AXELROD, D. I., 1966.
A method for determining the altitude of Tertiary floras.
Palaeobotanist 14:144-171. Illus.

Author's Abstract

Since Tertiary climate was characterized by pronounced temperateness (M), the effective temperature (ET) of a Tertiary flora can be determined most accurately if inferences are drawn from analogous modern forests in areas of high temperateness (M60+). The regions where forests have persisted wth least change since the Tertiary (i.e. Szechuan, Yunnan, Puebla-Oaxaca, New Zealand, southern Chile, Canary Islands). The method devised to determine altitudes of stations in modern upland forests is applied to Tertiary floras

BAIRD, D., 1951.
Field expedients in vertebrate collecting.
Compass of Sigma Gamma Epsilon 29:112-114. No illus.

Vertebrate fossil collecting techniques are much more complicated than invertebrate techniques and require skill and training. Proper tools are important and need to be adapted to each specific find. To insure the specimen will arrive at the laboratory safely, it should be hardened, made as stable as possible, and placed in a plaster jacket.

BARDOSSY, G., 1961.
Kovasodott fatorzsek rontgendifraktometeres vizsgalata.
Foldt. Kozl. 91:442-444.

Silicified wood samples from various geologic ages were studied by X-ray diffraction methods. The Permian, Burdigalian and Helvetian samples contained quartz and chalcedony. Some of the Tortonian and Sarmation samples consisted predominantly of cristobalite and tridymite. Origin of cristobalite and tridymite was attributed to normal sedimentary processes.

BARTHOLOMEW, R. L., L. C. MATTEN, AND E. F. WHEELER, 1970.
Staining silicified woods.
Jour. Paleont. 44:905-907.

The utilization of the stains Bismark brown Y and Malachite green in the study of silicified woods was described. Malachite green is especially good for differentiating tissues in silicified plants.

BECK, C. B., 1955.
A technique for obtaining polished surfaces of sections of pyritized plant fossils.
Bull. Torrey Bot. Club 82:286-291. 5 Figures.

Author's Summary

The importance of studying structurally preserved portions of axes of compression specimens was stressed and several examples of previous work of this nature were cited. The two common types of fossil preservation in pyrite were discussed. A technique which facilitates the grinding and polishing of surfaces of pyritized plant fossils was described and its usefulness emphasized.

BEHRENSMEYER, A. K., 1978.
Taphonomic and ecologic information from bone weathering.
Paleobiology 4(2):150-162. 10 Figures, 2 Tables.

Author's Abstract

Bones of recent mammals in the Amboseli Basin, southern Kenya, exhibit distinctive weathering characteristics that can be related to the time since death and to the local conditions of temperature, humidity and soil chemistry. A categorization of weathering characteristics into six stages, recognizable on descriptive criteria, provides a basis for investigation of weathering rates and processes. The time necessary to achieve each successive weathering stage has been calibrated using known-age carcasses. Most bones decompose beyond recognition in 10 to 15 yr. Bones of animals under 100 kg and juveniles appear to weather

more rapidly than bones of large animals or adults. Small-scale rather than widespread environmental factors seem to have greatest influence on weathering characteristics and rates. Bone weathering is potentially valuable as evidence for the period of time represented in recent or fossil bone assemblages, including those on archeological sites, and may also be an important tool in censusing populations of animals in modern ecosystems.

BROOKS, H. K., 1965.
Underwater paleontological collecting techniques.
In Kummel, B. and D. Raup, (eds.), Handbook of Paleontological Techniques, W. H. Freeman and Co.:168-175.

The experience of collecting fossils underwater in Florida form the basis for this paper. The value of dredging equipment was discussed for those special situations where other methods are impractical. Methods used by the engineering profession in solving construction problems in shallow or deep water were briefly described. The advantages of scuba diving gear were brought out as a successful method especially in sinkholes, springs and underwater caverns in limestone terrain. Air lift and coring devices as underwater excavation tools were also considered.

BROUGHTON, P. L., 1974.
Conceptual frameworks for geographic-botanical affinities of fossil resins.
Can. Jour. Earth Sci. 11:583.

Author's Abstract

Solid-state analytical techniques have been applied to natural resins to establish paleogeographic-botanical frameworks. Infrared spectroscopy, X-ray diffraction, and differential thermal analysis were

the techniques utilized. Fossilized resins (ambers) and recent to modern natural resins (gums and copals) from 47 world-wide localities were used in the study.

North American fossil resins have distinctive infrared and thermal characteristics which distinguish them from type Baltic Sea coast ambers. Examination of recent gums and copals by solid-state analytical techniques indicates significantly higher volatile component fractions than in the more fossilized resins.

BURNS, D. A., 1975.
The preparation of organic microfossils for study as ultra thin sections on the transmission electron microscope. New Zealand Oceanograph. Inst. 2(7):86-89.

Techniques used for manipulation, embedding and thin sectioning of organic microfossils prior to their study on the transmission electron microscope were described. Modifications of previously described techniques for soft biological material allow them to be used for sectioning relatively hard organic microfossils.

CARRECK, J. N. AND S. J. ADAMS, 1969.
Field extraction and laboratory preparation of fossil bones and teeth, using expanded polyurethane. Geol. Assoc. London Proc. 80:81-89. No illus.

Although the cost of polyurethane preparations is high, time saved in safely recovering fractured and delicate fossils from the field justifies its expense. It provides a light, strong, protective casing. Much less skill and time are required for adequately removing fossils than is needed by more conventional means.

CHALONER, W. G. AND M. M. GAY, 1973.
Scanning electron microscopy of latex casts of fossil plant impressions.
Palaeontology 16:645-649. 1 Plate.

Rubber latex casts of fossil plant materials, such as Lepidodendrales, in fine grained matrices may be subjected to electron microscopy to reveal details of original epidermal structure. This technique allows for the study of microscopic detail from plant impression fossils although the cuticle is not preserved.

CHANDRASEKHARAM, A., 1975.
A simplified rapid transfer technique as applied to compression fossils.
Palaeontology 49:161-162. 1 Plate.

Author's Abstract

A simple and quick method for making transfers of fossil leaves preserved in shale is reported. Utilizing only acetone and cellulose-acetate film, the method is a refinement over earlier techniques which were developed for removing carbonized material from compression fossils.

CHAVE, K. E., 1964.
Skeletal durability and preservation.
In Imbrie and Newell (eds.), Approaches to Paleocology, J. Wiley, New York, 6:377-387. 3 Figures, 2 Tables.

The fossil record does not provide a complete picture of life assemblages or environments. Soft parts are commonly destroyed early and in many post depositional environments, mineralized hard parts are also lost from the record.

Skeletal materials exhibit a wide range of durabilities. Chemical durability is controlled by skeletal mineralogy, physical durability is controlled by the microarchitecture of the shell, and biological durability is complex and not well understood.

Paleoecologic interpretations of fossils from assemblages of rocks representing high-energy environments are difficult because of selective destruction of skeletal elements. Interpretations of fossils from assemblages of rocks representing low energy environments are more satisfactory.

CLEMENS, W. A., 1965.
Collecting late Cretaceous mammals in Alberta; in Cypress Hills Plateau, Alberta and Saskatchewan.
Alberta Soc. Petr. Geol., 15th Ann. Field Conf. Guidebook:137-141.
2 Figures.

Author's Abstract

The "washing" or "underwater screening" technique for collecting microvertebrate fossils, which has been successfully applied to many Cretaceous deposits in the United States, was briefly described. In 1964, this technique was used in a search for microvertebrate fossils in the Upper Edmonton Formation. Collections obtained from this and approximately contemporaneous formations in the United States give evidence of a mammalian evolutionary radiation, apparently including significant geographic differentiation, in North America during the Late Cretaceous.

CREPET, W. L., 1978.
Investigations of angiosperms from the Eocene of North America: An aroid inflorescence.
Rev. Palaeob. Palyn. 25:241-252. 3 Plates.

Two spadix-like fossils were studied using light and scanning electron microscopy of the preserved cuticle and high magnification photomacrography of the impression with oblique lighting to highlight its structural details.

CREPET, W. L. and D. L. DILCHER, 1977.
Investigations of Angiosperms from the Eocene of North America: A mimosoid inflorescence.
Amer. Jour. Bot. 64(6)714-725. 17 Figures, 1 Table.

The nature of the preservation of the fossil inflorescence investigated required some specialized techniques. These were related to the studying of the pollen and anther. Collodion peels were made of the whole anthers rather than by manipulating whole anthers.

CREPET, W. L., D. L. DILCHER AND F. POTTER, 1975.
Investigations of angiosperms from the Eocene of North America: a catkin with juglandaceous affinities.
Amer. Jour. Bot. 62:813-823.

The authors used a modified collodion peel transfer method by applying several coats of collodion thinned (1:1) with ethyl alcohol-ether solution. The dry peel is removed by loosening the matrix with needles. The matrix is then dissolved by HF. This exposes the 3-D aspects of the fossil. Cuticle and whole anthers were teased from the matrix with hypodermic needles.

CRIDLAND, A. A. AND WILLIAMS, J. L., 1966.
Plastic and epoxy transfers of fossil plant compressions.
Bull. Torrey Bot. Club 93:311-322, 3 Figures.

Authors' Abstract

Walton's transfer technique has been modified for use with polyester plastics and epoxy resins. Besides conferring conveniences in handling and processing, these materials allow the preparation of large size transfers.

DAGHLIAN, C. P. AND T. N. TAYLOR, 1979.
A new method for isolating pollen and spores from acetate peels for scanning electron microscopy.
Rev. Palaeobot. Palynol. 27:85-89. Illus.

Author's Abstract

A procedure for precisely extracting pollen and spores from cellulose acetate peels made from Carboniferous permineralizations is described. This

technique produces either whole or sectioned clean grains and allows for the correlation of morphological and ultrastructural features by scanning electron microscopy. The critical examination of pollen and spores from peels prepared for earlier studies is now possible using this technique.

DARRAH, W. C., 1941.
Studies of American coal balls.
Amer. Jour. Sci. 239:33-53.

This article presented a general discussion of coal ball floras in the United States with emphasis on those of Des Moines age in Iowa, eastern Kansas and northwestern Missouri. These were compared to coal ball floras of Europe. The chemical nature and possible origin of these unique structures were discussed. Methods of study were also presented.

DARRAH, W. C., 1960.
Principles of paleobotany.
Ronald Press Company, New York. 295 p.

The author mentioned several solutions used to macerate bituminous coals. These consist of a mixture of hydrochloric and nitric acids plus a few crystals of potassium chlorate with sodium hydroxide and ethyl alcohol. The coal specimens are placed in the solution until a sludge is formed and then the cuticles and other organic material can be separated.

DEMANET, A. F., 1935.
The systematic collecting of fossils: What is the best way of forming a collection?
Museums Jour., London 35:288-294. No illus.

When fossil specimens are collected without regard to their topographical and stratigraphical position, their value is diminished. The best collections of fossils are based on regional investigations carried out by professionals. The whole fauna of a locality, its topographic position, the petrographic characters of the facies, the tectonic aspect of the rocks, faunal associations, trails, distortions of fossils, and

lithology must be investigated to reconstruct the complete environment and history of the ancient life. If collecting is done in this manner, then an important contribution to the problems of paleontology can be developed.

DILCHER, D. L., 1963.
Cuticular analysis of Eocene leaves of Octoea obtusifola.
Amer. Jour. Bot. 50:1-6.

Organic material was scraped from fossil leaves assigned to the Lauraceae into test tubes containing bleach (5% sodium hypochlorate solution). Cuticle from this material was later rinsed, stained and mounted on glass slides. Fossil leaves normally split open in the area of the decomposed mesophyll so that the upper cuticle is attached to one surface of the matrix and the lower cuticle remains with the other.

DORF, E., 1965.
Plants--Mesozoic and Cenozoic forms.
In: Kummel, B. and D. Raup, (eds.), Handbook of Paleontological Techniques, W. H. Freeman:127-134. 2 Figures.

Most of the megascopic nonmarine remains preserved in rocks of Mesozoic or Cenozoic age are fossil leaves. Shales, especially those associated with coals, are good sources of plant fossils. Also the finer grained pyroclastics are excellent for preservation of a great variety of remains. Techniques are divided into locating plant-bearing beds, quarrying for good specimens, what to collect, field sorting, wrapping and laboratory preparation.

DOWNS, T., 1967.
Airlift for fossils
Terra 6:20-25. 18 Figures.

Using a helicopter to transport bags of sediment from a collecting site with difficult access to a screening area or waiting trucks is an excellent way to move large amounts of sediment with minimal fossil breakage or manual labor. In a matter of hours bags of sediment, which would take days to transport by hand, can be moved.

DURHAM, J. W., 1967.
The incompleteness of our knowledge of the fossil record.
Jour. Paleont. 41:559-565. 1 Table.

Author's Abstract

Consideration of the doctrine of evolution and the implications of the biological species concept indicate that our knowledge of the fossil record will not be complete until we have a continuum of morphologies between all taxa with preservable parts. As an important corollary to the biological species concept, it is emphasized that species boundaries between sequential taxa will have to be arbitrary.

The recorded California Pleistocene marine invertebrate fauna is only about two-thirds as large as the living fossilizable fauna of the same region. Tertiary marine faunas of the reasonably well studied California area are even smaller. For contrast a probable 657 species of over 3000 taxa have been recorded from the Eocene of the Paris Basin. On the basis of a sample of over 67,000 molluscs collected by screening a late Pleistocene marine pocket near Newport, California, 427 taxas were recognized. A 1 per cent sample obtained in the same manner would have yielded only 153 taxa, while a sample of 68 specimens (0.1% of original collections) would yield only 48 taxa. These data emphasize the deleterious effect of small collecting samples.

The occurrence of the coral genera Dasmia and Dendrosmilia in the Pacific Coast Cenozoic, when previous records were restricted to Western Europe, underscores our poor knowledge of the geographic distribution of fossils. The occurrence of the Helicoplacoidea, Eocrinoidea, Edrioasteroidea, Camptostromoidea, and an unnamed class of echinoderms in the Early Cambrian indicates that echinoderms equipped with hard parts existed in the Precambrian. Analysis of fossilizable marine invertebrates and the

known fossil record suggests that we know only about one of every 44 (and probably fewer) taxa of those that have existed in this environment since the beginning of Cambrian.

FAGER, E. W., 1972.
Diversity: a sampling study.
Amer. Nat. 106:293-310. 3 Figures, 3 Tables.

Author's Introduction

Sanders (1968, 1969) has presented an extensive discussion of the use of diversity measures in description of marine benthic communities. He has proposed a method for dealing with a problem that has been of concern to ecologists for some time; the fact that diversity measures change with changes in the number of individuals in a sample. Although the method is attractive, it seemed unlikely that the predicted number of species would be observed if smaller samples were actually obtained by random sampling. In order to test the rarefaction technique, a program was written to simulate sampling from various spatial distributions. It also calculated for each sample, three diversity indices discussed by Sanders as well as a new index proposed in this paper, and the standard deviation of numbers of individuals per species.

FAGERSTROM, J. A., 1964.
Fossil communities in paleoecology: their recognition and significance
Geol. Soc. Amer. Bull. 74:1197-1216. 5 Figures.

Author's Abstract

Fossil assemblages consist of individuals that were members of one or more ancient communities. Four types of fossil assemblages, (fossil communities, residual or winnowed fossil communities, transported fossil assemblages, and mixed fossil assemblages) may be differentiated on the basis of amount, and in some cases, cause of preburial alteration. The most damaging agents to marine communities are predators, scavengers, and

especially bottom currents which selectively remove shells. To assess the preburial alteration of a particular fossil assemblage one must evaluate as many of the following criteria as can be reasonably applied: size-frequency distributions, ratio of articulated to disarticulated valves, ratio of opposite valves, dispersion of fossils, population density, community density, faunal composition and diversity, orientation of clastic particles (including fossils), texture, sorting, and structure of sedimentary aggregate, lithofacies relationships, surface condition of fossils, and ratio of whole to fragmented shells. Replacement, leaching and crushing of shells are the causes of most postburial alteration and may profoundly influence the criteria for preburial alteration.

Analysis of fossil assemblage from the Pennsylvanian of Nebraska indicates that the specimens have been subject to considerable postburial crushing which has reduced the significance of some of the criteria for assessing preburial alteration. Nonetheless, right-skewed size-frequency distributions for two species of fossil invertebrates give strong indication that this assemblage is a fossil community. This conclusion is supported by the fact that the elongated shells show no tendency toward parallel alignment and the absence of primary sedimentary structures indicative of deposition from strong directional currents.

Note: This study deals exclusively with the marine faunas; however, much of what the author concludes is appropriate for non-marine, especially fresh water forms as well.

FISHER, D. W., 1965.
Collecting in sedimentary rocks. In Kummel, B. and D. Raup, (eds.), Handbook of Paleontological Techniques, W. H. Freeman and Co. 150-155.

This article tells where to find fossils within sedimentary rocks and what types of sedimentary rocks are generally most productive in their yield of fossils. The paper also lists types of samples to collect and the proper tools and equipment needed to extract fossils.

FISHER, R. A, A. S. CORBET, AND C. B. WILLIAMS, 1943.
The relationship between the number of individuals and the number of species in a random sample of an animal population.
Jour. Anim. Ecol. 12:42-48. 8 Figures, 7 Tables.

In biological groups, species are not equally abundant. A majority being comparatively rare while only a few are common. It has been determined that a mathematical relationship exists between the number of individuals and the number of species in a random population sample. This paper compares three different samples from three populations.

FLESSA, K. W., 1975.
Analysis of fossil diversity gradients.
Geol. Soc. Amer. Abstr. Programs 7:58-59. No illus.

Author's Abstract

The geographic and temporal diversity gradients seen in the fossil record can provide information about the environmental regimes represented by the enclosing sedimentary rocks and about the adaptive strategies that organisms have employed. An information function is a desirable means of estimating diversity but its use may be precluded by the preservational biases and small sample size typical of many fossil collections. Fortunately, for many paleoecological applicants, a simple count of the number of taxa present will often suffice as a diversity measure.

Regional diversity gradients reflect systematic regional variation in environemtnal predictability and/or spatial heterogeneity. Diversity gradients may parallel environmental gradients not reflected in the physical stratigraphic record. Global diversity gradients within fossil taxa provide an independent check on paleoclimatic and paleogeographic reconstructions. Trend surface analysis can be used to suppress some of the "noise" in the fossil record while detecting geographic diversity patterns.

Temporal diversity gradients include those which result from ecological succession and those which result from the evolutionary processes of extinction and speciation. Coincident changes in relative taxonomic diversity through time can be revealed through the application of various factor analytic methods. The rate of change of diversity in geologic time is an evolutionary rate and reflects changes in the global environmental regime of the occurrence of adaptive breakthroughs.

FOX, W. T., 1962.
Stratigraphy and paleoecology of the Richmond Group in southeastern Indiana.
Geol. Soc. Amer. Bull. 73:621-642. 10 Figures.

As part of a larger study, the author described various methods of collecting statistically significant samples of fossils. Methods used by Petersen (1915) and Thorson (1957) were briefly outlined. Approaches using a standard area for taxonomic analysis was described and used by Fox in his study of the Richmond fauna. A census of taxa was achieved by counting five areas of 0.02 m^2 or each bedding plane in order to sample the fauna appropriately.

Fox concluded this section of his study by listing three conditions or "principles" that apply to assemblage zones (Thienemann, 1954):

1. The variety of species is greater under more diverse conditions.
2. The variety of species is reduced, but the individual numbers are increased in a community as the environmental conditions depart from the normal or optimum for most of the species concerned.
3. The variety of species, balance, and stability of the community are greater as the conditions in a given environment become more stable and continuous.

FOX, W.T., 1968.
Quantitative paleoecologic analysis of fossil communities in the Richmond Group.
Jour. Geol. 76:613-640.

Author's Abstract

The thin-bedded limestone and shale beds of the Tanners Creek Formation are divided into five assemblage zones. Within each assemblage zone, the organisms are grouped into fossil communities. The Tanners Creek Formation, which is the basal unit of the Richmond Group of Upper Ordovician age, is about 70 m thick where it outcrops in southeastern Indiana. Time-trend curves for twenty-three fossil types are plotted to study the distribution of the organisms within the Tanners Creek Formation. A computer program was compiled to compute and plot the time-trend curves which are used to divide the formation into assembalge zones. A twenty-one-term smoothing equation is used for the major trends and a seven-term equation for the short-period fluctuations in the faunal distribution. The following assemblage zones are named for the dominant pairs of brachiopod genera: Zone A, Refinesquina-Aygospira; Zone B, Resserella-Zygospira; Zone C, Resserella-Sowerbyella; Zone D, Platystrophia-Leptaena; and Zone E, Rhynchotrema-Plaesiomys. Within each assemblage zone, the fossils which occur most frequently together are grouped into fossil communities. Within each assemblage zone the product-moment correlation coefficients are computed between each pair of fossils. The fossils are grouped into communities, using an R-mode cluster analysis computer program. The major fossil communities which transcend assemblage zone boundaries include (1) Rafinesquin-Qygospira community, (2) crinoid-trilobite community, (3) bryozoan community, (4) Resserella community, and (5) Hebertella-Strophpmena community. Field observations on the condition and orientation of the fossils are used in conjunction with point-count data on the fossils and matrix to interpret

the depositional environment and its relationship to the assemblage zones and communities. A principal-components factor analysis computer program with a varimax rotation is used to study the relationship between the organisms and their environment. Based on the interpretation of field and thin-section data, a marine regression occurred from Zone A to Zone C, with a transgression in Zone D and a regression in Zone E.

Note: The study of the Richmond Group involves marine invertebrates only; however, the author's approach would be valid in an effort to collect a statistically significant sample of non-marine invertebrates as well.

FRONDEL, J. W., 1967.
X-ray diffraction study of fossil elemis.
Nature 215:1360-1361. Illus.

X-ray diffraction identification of Alpha-Amyrin in quaya quillite, Highgate copalite and glessike places these fossil resins among the elemis in the Burseraceae family of angiosperm. Correlation of their geographical occurrences lends support to the belief that the so-called Amber Forests flourished during Eocene as well as Oligocene times. The thin-layer chromatograms were made on Merck glass-plates, pre-coated with silica gel containing a fluorescent indicator. The resins were dissolved in 1:1 solution of ethyl acetate and methyl alcohol.

GRAHAM, R., 1933.
Preparation of paleobotanical sections by the peel method.
Stain Technology 8:65-68.

The use of nitrocellulose peels in the study of petrified plant materials has resulted in experimentation with various nitrocellulose solvents used commercially in the manufacture of laquers. A new solution

was proposed and the paper also dealt with the effects on the resulting film of the various grades of nitrocellulose, the various solvents used, and plasticisers and other substances which may be added to the solution.

GRAYSON, D. K., 1978.
Reconstructing mammalian communities: a discussion of Shotwell's method of paleoecological analysis.
Paleobiology 4:77-81. 4 Figures.

Author's Abstract

Shotwell's method of paleoecological reconstruction attempts to define community membership of mammals represented within paleontological assemblages. Analysis of the measure of community membership upon which the method is based (relative skeletal completeness) shows this measure to be a function of sample size. A method for controlling for the effects of sample size upon measures of relative skeletal completeness is needed. A method is suggested which employs ratios of numbers of individuals to numbers of specimens, and a specific correction of Shotwell's method is proposed.

GREELEY, R., 1970.
Note on a specimen collecting seive.
Jour. Paleont. 44:1132-1133. 1 Figure.

This short article outlined a step by step procedure to build a very effective and easily constructed collecting seive which can be used to collect specimens in sand or in unconsolidated sediments.

GUNTHER, F., V. G. GUNTHER AND J. K. RIGBY, 1979
An economic miniature sandblaster for preparation of fossils
Jour. Paleont. 53:506-507. 1 Figure.

An inexpensive small air abrasive unit currently being sold commercially for ink erasing, instrument and jewelry cleaning; can readily

be adapted for fossil preparation. The adaptation greatly reduces wear on the apparatus, making it functional for longer periods. By using small bottles of gas, the unit can be used in the field to remove small fossils which may be difficult to extract by more conventional methods.

HAMMEN, T. V., 1964.
Palaoklima, stratigraphie und evolution.
Geol. Rundsch. 54:428-441. 9 Tables.

The ideal pre-Quaternary pollen-diagram may give a picture of the vegetation in space and time. Vegetative changes are determined principally by two factors: climatic changes and relative changes of sea level. It was shown that during Upper Cretaceous and Tertiary time, cyclic changes of vegetation have occurred. These were determined by climatic variations and by the fact that temperatures were apparently lower at the boundaries of the international stratigraphic units.

Climatic cycles appear to furnish a base for stratigraphical subdivision on which chronostratigraphy is based and on which biostratigraphy appears to be dependent.

HARMS, V. L. AND G. A. LEISMAN, 1961.
The anatomy and morphology of Cordaites.
Jour. Paleont. 35:1041. No illus.

Limestone, containing fossil leaves, was placed in hydrochloric acid (10%) until the cuticle and attached carbonized tissues separated from the rock. The freed organic material is dark brown or black in appearance and very fragile and limp. It is washed and put into sodium hypochlorate (10%) with constant checking to avoid over-bleaching. The remaining organic substances are washed, stained and mounted.

HARPER, C. W., JR., 1975.
Standing diversity of fossil groups in successive intervals of geologic time: a new measure.
Jour. Paleont. 49:752-575. 3 Figures, 3 Tables.

Author's Abstract

The total number of taxa of given rank of a fossil group known from each of several successive intervals of geologic time is commonly used as a measure of the relative taxonomic diversity of the group during the respective time intervals; this procedure is not justified, particularly not as a measure of standing diversity. For the common case of a fossil group with relatively long-ranging taxa, an estimate of the taxonomic diversity of the group at the midpoint of a time interval is proposed as a measure of its standing diversity during the interval, or, more precisely, its standing diversity at one point in time during the interval. This estimate is calculated for 1) genera of suspension-feeding bivalve molluscs in the Ordovician to Jurassic, 2) families of all major groups of fossil animals in the Cambrian to Tertiary, and 3) skeletonized families of shelf benthose in the Cambrian to Tertiary. All three groups show a similar pattern: an increase in diversity in the Early Paleozoic, a diversity low in the Late Devonian-Early Mississippian, a more pronounced diversity low in the Early Triassic, and a systematic increase in diversity in successive time intervals after the Early Triassic.

HARRIS, T. M., 1956.
The fossil plant cuticle.
Endeavor 15:210-214.

In working with coal or other fossil materials, Harris places these materials into a mixture of nitric acid and potassium chlorate for a few hours or at least until its color has changed from black to brown.

It is rinsed and placed in ammonia for bleaching. This forms a black solution, and the cuticle is left as a transparent membrane.

HECK, K. L., JR., G. V. BELL, AND D. S. SIMBERLOFF, 1975.
Explicit calculation of the rarefaction diversity measurement and the determination of sufficient sample size.
Ecology 56:1459-1461. 1 Figure.

Author's Abstract

An explicit means of calculating the expected number of species [E(Sn)] and the variance of (Sn) in a random sample of n individuals from a collection containing N individuals and S species is presented. An example illustrates a new use of E(Sn): determination of the sample size required for any desired degree of accuracy in collecting species known to occur in a particular area.

HERMANN, A., 1908.
Modern methods of excavating, preparing and mounting fossil skeletons.
Amer. Nat. 62:43-47. No illus.

Proper treatment of bones in the field is vital. Gum arabic has been extensively used to harden fragile bones, but has the disadvantage of not being water proof. Shellac is harder, absolutely waterproof, and penetrates bones better than gum arabic. Brown shellac is best but white shellac will not discolor the bones.

HIBBARD, C. W., 1948.
Technique of collecting microvertebrate fossils.
Geol. Soc. Amer. Bull. 59:1330. No illus.

Thousands of small invertebrate and vertebrate fossils, many new to science, have been recovered by sifting and washing of matrix. Sands, sandy silts, and clays, which contain fossils, are dried, placed in water, and sifted through a series of screens. The majority of the matrix is washed away and the fossils are exposed and can be picked out.

HIBBARD, C. W., 1949.
Techniques of collecting microvertebrate fossils.
Mich. Univ. Mus. Paleont. Contrib. 8:7-19. 8 Figures.

Using the process of sifting and washing unconsolidated sediment, numerous microvertebrates can be obtained from otherwise unproductive beds. This paper outlines methods of sifting and washing and how these methods worked at fossil localities in Kansas and Oklahoma.

HILL, A., 1979
Disarticulation and scattering of mammal skeletons
Paleobiology 5(3):261-274.

Author's Abstract

This article presents a statistical technique for determining the disarticulation sequence of vertebrate skeletons based on the relative numbers of different intact joints in an assemblage of bones. For remains of modern Topi (Damaliscus korrigum) on the margin of Lake Turkana, northern Kenya, the disarticulation pattern is very consistent. This sequence, on dry land, differs from that reported for bovids that have disarticulated in the presence of water. On land the bones first released as single bones are those moved least easily by currents of moving water. The last released are those moved most easily. A model of random scattering was developed that suggests that the rate of dispersion is great at high concentrations of bones and decreases rapidly as the distance between bones increases. This leads to a condition where scattering effectively stops. The area of more or less stabilized dispersion is dependent only upon the mean distance that each random event moves a bone. Tests show that it is unlikely that articulated units themselves are much involved in scattering, and scattering appears to take place throughout the course of disarticulation.

HOLTZMAN, R. C., 1976.
The estimation of the completeness of species lists and the optimization of sample size in paleontology.
Geol. Soc. Amer. Abstr. Programs 8:923. No illus.

Author's Abstract

One of the most common problems in paleontology is deciding whether or not a sample is large enough to adequately represent the fossil assemblage from which it is drawn. The results of samplings simulated by using Monte Carlo methods on a computer provide a new means of (1) estimating the completeness of a species list (the fraction of the species ultimately obtainable from a locality), and (2) deducing an optimum sample size, one that will result in a desired value of completeness. It is assumed that the frequency distribution of species at any locality is one of a family of functions derived from the distribution function of MacArthur's (1957, 1960) "broken stick" model by raising the denominator in that expression to an arbitrary exponent. A series of simulated species-list growth curves (number of species vs. sample size) form the basis of the estimate of completeness. The frequency distribution of species in sample is used to obtain a best fit value of the exponent, thus selecting the one member of the family of functions that best describes the frequency distribution being sampled. The estimate of completeness is then obtained by a two-step iterative interpolation between species-list growth curves. An optimum sample size can be found directly from the interpolated growth curve corresponding to the estimated value of the exponent. These procedures are independent of preservational biases and the methods used in collecting the sample, but similarly the predictions apply only to the fossil assemblage as modified by the methods used in the collection and study of the sample. Except for those having very few species (less than about ten), these results are applicable to all types of fossil assemblages.

HOLTZMAN, R. C., 1979
Maximum likelihood estimation of fossil assemblage composition
Paleobiology 5:77-89. 5 Figures, 1 Table.

Author's Abstract

The most common methods of estimating the relative abundance of species in a fossil assemblage are all maximum likelihood estimates. They differ from one another in their inherent assumptions made about the effects of fragmentation and differential preservation in the assemblage. For many fossil assemblages, relative abundance is best estimated by the relative frequency of specimens or relative frequency of elements. Monte Carlo simulations suggest, however, that in most other circumstances estimates based on frequency of elements divided by the number of elements in a complete individual provide greater accuracy than estimates based on minimum number of individuals. This relation results from an interaction between random sampling error and a variety of biases inherent in the two estimates.

HOSKINS, J. H., 1930.
Colloidin transfer method for thin rock sections.
Bot. Gaz. 89:414-415.

It is sometimes desirable to transfer thin sections from glass slides on which they are ground to other slides free from abrasion. Often, when this is attempted, the sections are broken. By placing a film of commercial colloidin between the specimen and the original slide, such a transfer can be made with a minimum of loss.

HOTTON, N., III, 1965.
Tetrapods.
In B. Kummel and D. Raup, (eds.), Handbook of Paleontological Techniques, W. H. Freeman and Company: 119-124. No illus.

Tetrapod remains are found in clastic rocks of all kinds and locally

may be very abundant, although they are generally scarce. They are commonly found in a moderately well-indurated shale or very fine-grained sandstone and are slightly more resistant to weathering than the surrounding rock. They may also be found in nodules, soft shale in which the bone is softer, laminated shale and in hard channel sandstone.

Each type of rock requires different collecting techniques and tools. Fossils found in soft rock should be placed in a plaster jacket, while fossils in nodules or indurated rock may be shipped with minor protection.

The basic equipment needed includes a geologist's hammer for digging in tough shale, a Marsh pick for clearing unconsolidated sediments, chisels, a jackknife, whisk brooms, paint brushes, hardeners, tissue and newspaper.

HUDSON, G. H., 1916.
Some notes on fossil collecting and on the Edrioasteroidea.
Ottawa Nat. 30:21-25, 40-46. 2 Figures.

Fossil collectors can be divided into three main groups: the collector who keeps fossils out of curiosity, the collector who devotes his collecting to complete or perfect specimens, and the scientific collector who wants to develop or illustrate biologic laws and our concept of evolution.

The first two groups are, many times, destructive. It is our duty to preserve fossil material for study by professionals because, in many cases, fragments alone may be of inestimable value.

HURLBERT, S. H., 1971.
The nonconcept of species diversity: a critique and alternative parameters.
Ecology 52:577-586. 2 Tables

Author's Abstract

The recent literature on species diversity contains many semantic, conceptual, and technical problems. It is suggested that, as a result

of these problems, species diversity has become a meaningless concept, that the term be abandoned, and that ecologists take a more critical approach to species-number relations and rely less on information theoretic and other analogies. As multispecific collections of organisms possess numerous statistical properties which conform to the conventional criteria for diversity indices, such collections are not intrinsically arrangeable in linear order along some diversity scale. Several such properties or "species composition parameters" having straight-forward biological interpretations are presented as alternatives to the diversity approach. The two most basic of these are simply:

$$\Delta_1 = \left[\frac{N}{N-1}\right]\left[1-\sum_i\left(\frac{N_i}{N}\right)^2\right]$$

= the proportion of potential interindividual encounters which is interspecific (as opposed to intraspecific), assuming every individual in the collection can encounter all other individuals,

and

$$E(S_n) = \sum_i\left[1 - \frac{\binom{N-N_i}{n}}{\binom{N}{n}}\right]$$

= the expected number of species in a sample of n individuals selected at random from a collection containing N individuals, S species, and N_i individuals in the ith species.

JONES, D. B., 1975.
Amateur fossil hunters get professional help -- and vice versa.
Earth Science 28:209-210. No illus.

It is time that professional paleontologists have a strong vested interest in educating the majority of amateur fossil collectors. Too many of the latter destroy specimens by improper collecting techniques. Sometimes, whole skeletons are destroyed in an attempt to salvage parts that can be sold (e.g. teeth, vertebrate, etc.). However, most amateurs are conscientious and may need only a few pointers on technique. Since

many professional paleontologists do not have sufficient time for field work, a satisfactory solution to the problem might be assistance by trained amateurs.

JOY, K. W., A. J. WILLIS, AND W. S. LACEY, 1956.
A rapid cellulose peel technique in paleobotany.
Ann. Bot. n.s. 20:635-637.

A thin cellulose acetate film is used in conjunction with a small quantity of solvent. The solvent is sufficient only to dissolve the film adjacent to the fossil. The film is then easily removed when most of the solvent has evaporated. The method is quick, cheap and materials are readily obtainable.

IMBRIE, J., 1955.
Quantitative lithofacies and biofacies study of Florena shale (Permian) of Kansas.
Amer. Assoc. Petrol. Geol. Bull. 39:649-670. 11 Figures.

Author's Abstract

The purpose of this study is to test the practicality and scientific potential of an analytical technique designed to produce quantitative data on biofacies and lithofacies changes. The unit selected for analysis is the Florena shale member of the Beattie limestone (Wolfcampian), a fossiliferous unit traceable across Kansas from Nebraska to Oklahoma. Trench samples of standard size were disaggregated, sieved, and selected fractions picked for fossil material. The abundances of selected taxonomic groups were then expressed in terms of weight. The abundances of many groups of fossils show systematic variations with respect to stratigraphic position or lithologic association; and it is therefore probable that (in these cases) significant changes are being measured. In two localities, abundance patterns of many groups of fossils are strikingly similar and related to changes in the size of fossil fragments. These faunas are interpreted as dominantly current-drifted. At a third locality, where

abundance data are compared directly with lithologic data, there is no clear relationship between the percentage of insoluble residue and the abundance of any fossil group, although a striking correlation is shown between the abundance of a number of groups and the strontium-calcium ratio of the carbonate portion of the shale. The significance of this correlation is uncertain, but the hypothesis is advance that both the strontium-calcium ratio and the fossil abundances related to it reflect the salinity of the Florena sea.

KAUFFMAN, E. G., 1965.
Collecting in concretions, nodules and septaria.
In Kummel, B. and D. Raup, (eds.), Handbook of Paleontological Techniques, W. H. Freeman and Co.:175-184.

Concretions were discussed as potentially excellent sites of fossil preservation. The origin and variation of concretions, nodules and septaria was briefly related. Special problems unique to extracting fossils from these structures were considered in this paper. Necessary equipment, search methods and lithologic characteristics which affect fossil collecting were discussed.

KAUFFMAN, E. G., J. D. POWELL, AND D. E. HATTIN, 1969.
Cenomanian-Turonian facies across the Raton Basin.
Mt. Geol. 6:93-118. 4 Figures.

Author's Abstract

Cenomanian and Turonian rocks in and marginal to the Raton basin include, in ascending order, the upper Dakota Group, Graneros Shale, Greenhorn Limestone, Carlile Shale, and basal beds of the Fort Hays Limestone. These represent a nearly complete record of paleoenvironments developed near the center of the Western Interior basin during the Greenhorn marine cycle and transgressive phases of the Niobrara marine cycle, and are part of the data from which a model for Cretaceous cyclic sedimentation is drawn. During transgression, these rocks reflect four

time successive environmental suites: (1) coastal plain fluvial, lagoonal, estuarine, and marginal marine sand environments; (2) shallow inner sublittoral shelf clastics (sand and silt); (3) offshore mud environments at midshelf depth; and (4) a shallow midbasin carbonate platform suite.

Detailed paleontologic analysis of this area allows construction of a refined local biostratigraphic zonation, within which some new zones and subzones are proposed: (1) Inoceramus bellvuensis "Ostrea noctuensis zone of the upper Dakota Group and lower Graneros Shale; (2) Acanthoceras wintoni of the middle Graneros Shale (upper level of the Thatcher Limestone Member); (3) and two subzones of the Mytiloides labiatus zone in the upper Bridge Creek Limestone. These are: (a) the "Gryphaea (Pycondonte?) newberryi subzone (lower), and (b) the Pycondonte bentonensis subzone (upper). Both oysters range into adjacent units without M. labiatus labiatus.

KENNEDY, C. M., 1978.
An improved technique for revealing the internal structure of microfossils by scanning electron microscopy.
Jour. Paleont. 52:506-508.

Author's Abstract

An improved sectioning method of revealing internal morphology of Foraminifera (Kennedy & Zeidler, 1976) has application for the preparation of specimens for scanning electron microscopy. The sectioning and subsequent removal of the embedding medium (Mowilith No. 20) reveals important microstructures rarely seen by random fracture methods.

KERMAC, K. A., 1965.
Problems of collecting from fissures.
In Kummel, B. and D. Raup, (eds.), Handbook of Paleontological Techniques, W. H. Freeman and Co.: 203-206.

Caves and fissures were discussed as potential sites for collecting

fossils. Fissures were noted as important sites of Early Tertiary mammal fossils in Europe. Identifying characteristics of such deposits were described and their origin discussed. The difficulties of finding and collecting fossils from fissures were emphasized.

KERMACK, K. A., P. M. LEES, AND F. MUSSETT, 1965.
Aegialodon dawsoni, a new trituberculosectorial tooth from the Lower Wealden.
Proc. of the Royal Soc. of London, Ser. V. 162:535-554.
13 Figures.

Blocks of quartz sandstone bound with calcareous cement, which contain fossils, are immersed in 10% formic acid. As loose material falls or is washed off the block, it is collected, dried, and screened. A block 12 in. square and 4 in. thick takes between 2 and 3 months of continuous immersion to disintegrate completely.

After screening, a floatation procedure using tetrabromoethane and dibromoethane is used to separate the bulk of the quartz from the fossil material.

KINDLE, E. M., 1916.
Fossil collecting.
Ottawa Nat. 29:117-124. 1 Figure.

Methods used in the collecting of invertebrate fossils were explained. Tools, acids, and collecting bag were considered. Ways to find fossils were discussed and the importance of proper stratigraphic and locality information emphasized.

KOCH, C. F., 1977.
Bias in the fossil record.
Geol. Soc. Amer. Abstr. Programs 9:1054-1055. No illus.

Author's Abstract

The published fossil record was found to have a significant bias in favor of common and biostratigraphically important taxa when compared

with data obtained from a thorough examination of several hundred collections from the Western Interior of North America. Evolutionary and ecological studies based solely on record would risk serious errorrbecause the comparison shows that; (a) overall species diversity would be underestimated by a factor of 3, (b) bivalve and gastropod diversity by a factor of 5, and (c) bivalve species duration would be overestimated by a factor of 2.

Abundance data obtained during this investigation indicate that, as expected, common taxa dominate the published data. The new taxa of this report were mostly uncommon and rare forms having restricted geographic distribution and much shorter species duration.

The fifteen published reports, although distributed relatively uniformly over the area, listed only 65 species for 203 reported occurrences. Data from all sources showed 170 species for 1050 occurrences. By using abundance data and assuming a log-normal distribution, 200 to 250 mollusk species are estimated to have inhabited the Western Interior during the uppermost biozone of the Cenomanian.

The number of ammonite species increased from 21 to 30, bivalves from 29 to 95, and gastropods from 10 to 32. This demonstrates that the biostratigraphically important ammonites have been previously well studied and documented.

The importance of this study is that it qualifies bias in the published fossil record for a relatively well studied time and area. The bias should be greater for less well studied strata.

KOSANKE, R. M., 1945.
Staining plant remains in calcareous coal balls.
Jour. Paleont. 19:658.

After cutting, polishing and etching the coal ball, the etched side is placed in a concentrated solution of safranine Y in warm water for 30 seconds or longer. After the etched surface has been stained, it is easier to determine the value of the material preserved than in unstained coal balls.

KRANZ, P.M., 1977.
A model for estimating standing crop in ancient communities.
Paleobiology 3:415-421. 3 Figures, 1 Table, 1 Appendix.

Author's Abstract

The paleoecologist has been hampered in his studies of ancient communities by an inability to obtain reasonable estimates of standing crops and diversities. Finding the diversity of an ancient community is no simple matter, because a fossil assemblage is a mixture of living and recently dead individuals from that community. Considerable numbers of each group may be missing. The relationship of the elements in a fossil population for an individual species can be expressed as follows: $F = F_l + F_d$, where F is the average number of fossil individuals collected per unit area, F_l is the part of the sample produced by the burial live individuals, and F_d is the part produced by the individuals already dead at the time of burial. F_l is a product of the standing crop S (number of individuals per unit area), multiplied by the probablity of failure P (proportion of the standing crop which can be expected to fail to escape

anastrophic burial), of $F_1 = (S).\ (P).$ F_d is the product of the death rate D (number of individuals which die per age-class time unit multiplied by the residence time R (average length of time expressed in age-class time units that the remains of an individual will persist after death), or $F_d = (D)\ (R)$. The probability of failure, residence time, and death rate can all be estimated from modern communities; the death rate can also be estimated from the fossils. Thus, the standing crop of an individual species can be expressed as follows:

$$S = \frac{F-(D)(R)}{P} .$$

This equation can be modified to eliminate the need to estimate D, as follows.

$$S = \frac{\sum_{i=1}^{n} F_i\ 1-[R/(R+P)]^i}{P} ,$$

where i is the subscript indicating the number of the specific age class where the youngest is 1 and the oldest is n. Once the standing crop for each species in the community has been estimated, a meaningful diversity can be calculated. Study of the model reveals that in populations where high-early mortality is the rule the likelihood of error in estimating population parameters is lower than for constant and low-early mortality populations.

KRASILOV, V. A., 1967.
Bulk maceration: a promising method in paleobotanic research.
Akad. Nauk. SSSR. Dokl. 174:1191-1194. Illus.

Many plants previously unknown in the Siberian Mesozoic flora were identified in sedimentary rocks from the Bureya River Basin (USSR) by complete maceration of large samples (Ca. 50 gr.) involving pretreatment with HCl and concentrated HF.

KRUMBEIN, W. C., 1965.
Sampling in paleontology. In Kummel, B. and D. Raup, (eds.), Handbook of Paleontological Techniques, W. H. Freeman and Co.: 137-150.

A description of general sampling methods was outlined in this article, which also emphasized simple random sampling techniques, or statistical sampling. The methods described are applicable to any type of lithology and in virtually all situations of collecting fossils when a statistical sample best fits the objectives of the study.

KUC, M., 1974.
Fossil mosses from the bisaccate zone of the mid-Eocene Allenby Formation, British Columbia.
Can. Jour. Sci. 11:409-421. 10 Figures.

Each fossil specimen was photographed before and after coating with transparent fingernail polish. Differences between the photographs revealed some important structures of fossil bodies.

Delicate cellular materials were studied after scraping them off with an application of alcohol and applying HF to remove any attached matrix.

KUHNE, W. G., 1971.
Collecting vertebrate fossils by the Henkel method.
Curator 14:175-179. 8 Figures.

The Henkel method is a semicontinuous washing method to collect small fossils from soft rock. A 1.7 horsepower pump forces water over sediment on a series of seives built into a large drum. Any fossil material is trapped on one of the seives while the fine matrix passes through.

LACEY, W. S., 1953.
Methods in paleobotany.
The North Western Nat. 24:234-249. 3 Figures, 1 Plate.

This paper is a survey of the more technical aspects of paleobotany, namely, the chief method in which knowledge of the structure of fossil plants has been obtained. The author mentioned the plant material in coal can be studied by ground sections and transmitted light, by polished surface and reflected light, by demineralizing, softening, embedding and microtoming, by peel sections and by maceration methods.

LANGENHEIM, R. L., JR., 1965.
Collecting amber. In Kummel, B. and D. Raup, (eds.),
Handbook of Paleontological Techniques, W. H. Freeman and Co.:184-189.

The potential of finding amber in Cretaceous and Tertiary rocks was brought out in this paper, and a description of the characteristics of amber was outlined. The occurrence and fossil yield of amber were also described. Various methods of detecting authentic from synthetic resins or gums was included in this paper.

LANGSTON, W. JR., 1948.
Vertebrate paleontological field technique and its application to archaeological collecting.
Texas Archeol. Paleont. Soc. Bull. 19:88-99. 5 Figures.

Paleontological collecting techniques including how to dig up, block out and jacket a specimen were described. Tools and equipment necessary were also examined and how these techniques can be used by archeologists was explained.

LARSON, D. W., 1977.
Differential shell burial and transport as a function of morphology; potential to bias the geologic record.
Geol. Soc. Amer. Abstr. Programs 9:620. No illus.

Author's Abstract

Studies with quantities of marked shells on the beach at Sapelo Island, Georgia reveal a pronounced hydraulic sorting of different shell morphologies as a function of rates of burial and transportation. Burial of a shell is a consequence of degree of mobility of that morphology. The wide, flat form of the sand dollar Melita is selectively buried relative to the rounded form of the gastropod Polinices, which is susceptible to longshore transport and therefore has a substantially lower burial rate. The bivalve Anadara , intermediate between Melita and Polinices in shape, is also intermediate in terms of selection for transport and burial. Consideration of overall size and mass of the shell is not sufficient to explain the observed hydraulic sorting. Induced flow separation accounts for shell burial, and the ability of a morphologic type to resist rotation controls transport.

Hydraulically sorted shell assemblages may enter the geologic record of high energy environments. Observations from Sapelo Island

indicate that hydraulic sorting results in strong preferred orientation of rapidly buried material; transported material remains exposed and is subject to fragmentation and abrasion. The buried assemblage is strongly biased toward morphologies that share hydraulic characteristics. Ancient shell assemblages associated with sedimentary structures indicative of high energy should be evaluated from a hydraulic standpoint. When morphologies of the members of such an assemblage are similar, the possibility exists that hydraulic sorting has removed part of the initial assemblage.

LASKER, H.,1976.
Effects of differential preservation on the measurement of taxonomic diversity.
Paleobiology 2:84-93. 5 Figures, 5 Tables.

Author's Abstract

A computer simulation was developed which estimates the effects of differential preservation on the value of taxonomic diversity in fossil assemblages. Taxonomic diversity was measured with the Sannon-Weaver index H' and the evenness, J. Preservation markedly alters quantitative measurements of taxonomic diversity. The degree of alteration can, however, be predicted on the basis of the species-abundance distribution and on the distributions of species of varying preservability. The indices of diversity H' and J measure different aspects of diversity, but respond to differential preservation in a similar manner. Evenness, J, is recommended for paleoecological use. The computer model can be used to revise fossil diversity data. A simple form of such a model has been used, and suggests that some previous interpretations of paleoecologic diversity may be in error.

LEBEDEV, Y. L, 1974.
Methods for study of sterile leaves of Mesozoic ferns.
Paleont. Zhur. 8:130-139.

Author's Abstract

Morphological analysis of sterile leaves of Mesozoic ferns was outlined. Main morphological characters and their diagnostic importance were considered. A method of making drawings of fossil plants directly from magnified impressions by means of a drawing apparatus attached to a binocular microscope was given. Typical mistakes that occur in the drawing of fossil ferns were examined. The article contained illustrations from a number of old works, and illustrations of the same plant items were made by the described method.

LECLERCQ, S. AND R. NOEL, 1953.
Plastic -- a suitable embedding substance for petrographic study of coal and fossil plants.
Phytomorphology 3:222-223.

A method for embedding coal suitable for petrographic studies was described in this note. The embedding containing the coal substance known as Marco 26C can be highly polished for examination under the microscope and in reflected light. The embedding resin is structureless and sharply contrasts with the coal.

LEES, P.M., 1964.
Floatation method of obtaining mammal teeth from Mesozoic bone-beds.
Curator 7:300-306. 2 Figures.

After rock containing fossils has been broken down by acid or mechanical treatment and passed through screens to remove unwanted particle sizes, the residue is placed in a heavy liquid, specific gravity of about 2.6. Fossil bone and teeth, specific gravity 2.7-3.0, sink to the bottom while the lighter residue, mostly quartz, floats and can be skimmed off.

The only known heavy liquids suitable for this work are bromoform ($CHBr_3$) and sym-tetrabromoethane ($C_2H_2Br_4$). Benzene or sym-dibromoethane is mixed with either of the above mentioned chemicals to adjust the specific gravity. All are toxic and should be handled with care.

LEPPER, H. A., JR., AND G. E. LEWIS, 1941.
Materials for preparation of vertebrate fossils. An analysis of their effectiveness.
Amer. Jour. Sci. 239:17-24. 1 Plate.

Author's Abstract

Tests of plaster of Paris beams impregnated with various plasters were made to evaluate the relative merits of these materials as strengthening agents for the preparation of fossil vertebrate specimens. It was found that gum arabic weakened the plaster specimens; while "Duro" cement gave but a slight increase in strength although it covered the specimens with a tough surface film. In the order given, shellac, "Egyptian" cement, "Alvar" and "Catalin" improved the strength to increasing degrees. Specimens in which gum arabic and dextrin were mixed with the plaster gave about the same strength as the untreated plaster of Paris. The relative advantages of these materials with regard to cost, color, and ease of use, as well as strength, are also discussed.

LILLEGRAVEN, J. A., 1969.
Latest Cretaceous mammals of upper part of Edmonton Formation of Alberta, Canada, and review of marsupial - placental dichotomy in mammalian evolution.
Univ. Kans. Paleont. Contrib. 50:1-122. 53 Figures.

One section of this article is concerned with collecting techniques. Detailed information is presented on obtaining and preparing material for screen washing as well as on the actual screening operation itself. New innovations concerning special screen washing conditions appear in this section. These are illustrated in part.

LINSLEY, R. M., 1965.
Collecting molds of fossils. In Kummel, B. and D. Raup, (eds.), Handbook of Paleontological Techniques, W. H. Freeman and Co.:189-191.

Ambition and patience are identified as the necessary traits of the successful fossil collector working with natural molds. The value and unique aspects of molds in the search for paleontologic data was emphasized. Methods of collecting, preparing and interpreting such collections were discussed.

LUNDELIUS, E., 1964.
The use of vertebrates in paleoecological reconstructions.
Ft. Burgwin Research Center 3:26-30. No illus.

Author's Introduction

The use of vertebrates for paleoecological reconstruction is based upon the known relationship of some attribute of the animal with one or more characteristics of the environment. These may be adaptations or phenotypic responses to the environment. A number of such correlations are common knowledge even among non-biologists. Others are less well known and some are quite subtle.

This paper reviewed various ways of obtaining information concerning past environmental conditions, the bases of these methods and their limitations. The term, environment, as used here, comprises both physical and biological factors.

MACDONALD, J. R., 1964.
A plea for fossil vertebrates.
Calif. Div. Mines Geol. Miner. Inform. Serv. 17:232-234.
No illus.

This is a short article explaining why vertebrate fossils should be collected only by professionals who have the proper tools and knowledge. Any fossil vertebrate found by amateurs should be left in place and the amateur should contact a paleontologist to help him recover the specimen.

MACFALL, R. P. AND J. WOLLIN, 1972.
Fossils for amateurs; a guide to collecting and preparing invertebrate fossils.
Van Nostrand Reinhold Co., New York, 341 p., illus.

This is a basic book explaining where fossils occur and practical techniques necessary to enjoy a day in the field collecting fossils. Invertebrates and plants are the fossils generally mentioned.

MAJOR, A., 1974.
Collecting fossils.
John Bartholomew and Son Ltd., Edinburgh, GBR., 209 p. Illus.

Fossil collecting does not require costly intricate equipment. Good hammers, chisels, crossbars, picks, penknife, trowels, magnifier, pencils, pens, collecting bag, and a system for recording sites and fossils are valuable. Fossils may be found at the base of cliff-faces, in rock exposures, man-made exposures, collapsed river banks, or in quarries. Fossils must be removed carefully from the rock, cleared, hardened, identified and adequately housed.

MAMAY, S. H., 1965.
Collecting coal balls.
In Kummel, B. and D. Raup, (eds.), Handbook of Paleontological Techniques, W. H. Freeman and Co.: 192-193.

This article briefly describes the characteristic productivity and occurrence of coal balls. Methods of finding, collecting, and shipping such specimens were discussed.

MARSHALL, L. G., 1976.
Paleontological salvage and federal legislation.
Jour. Paleont. 50:346-348. No illus.

Three federal acts directly affect paleontological resources: the Antiquities Act of 1906, the National Environmental Policy Act of 1969, and the Archaeological Conservation (or Preservation) Act of 1974.

Those sections of the Acts dealing with preservation of fossil sites and the collecting of fossils were discussed in some detail.

MATTEN, L. C., 1966.
Improved technique for preparing iron hydroxide plant petrifications.
Jour. Paleont. 40:225-226.

This technique improves the contrast and cellular detail of limonitic petrifications of plant materials. The specimens are impregnated and polished. They are then immersed in hot oxalic acid for 5-10 minutes, washed, dried and mounted. The acid lightens the color of the matrix and increases the contrast with the dark cell walls which retain some organic materials.

MCKENNA, M. C.,1962.
Collecting small fossils by washing and screening.
Curator 5:221-235. 6 Figures.

The most effective and efficient way to recover large numbers of small fossils is to screen large quantities of sediment and sort the dried concentrate. Should I screen? How do I screen? How do I make screens? How many screens and what screen sizes do I need?, are all questions answered by this paper.

MCKENNA, M. C., 1965.
Collecting microvertebrate fossils by washing and screening.
In Kummel, B. and D. Raup, (eds.), Handbook of Paleontological Techniques, W. H. Freeman and Co.: 193-203.

This paper is a discussion of "washing" as a method of concentrating microscopic vertebrate specimens. These methods are also useful in collecting microinvertebrate remains. The value of this procedure as a means of collecting a representative sample of a population of small fossils was emphasized.

The advisibility of screen washing a sample from a site was discussed, and characteristics of a potentially good site for washing were described. Equipment design, use and construction methods were also described.

MINER, E. L., 1935.
Paleobotanical examinations of Cretaceous and Tertiary coals.
Amer. Midl. Nat. 16(4):585-615.

Samples of Cretaceous and Tertiary coals were mascerated by soaking them first in dilute nitric acid (5-10%) for several months to a year depending upon the type of coal. The remaining sludge of sand, pollen, spores, cuticle and other organic substances was carefully washed and bleached with sodium hydrochloride (2%) for a few days. It was then washed and examined. The fossil materials were then separated.

MOOK, W. G., 1971.
Paleotemperatures and chlorinities from stable carbon and oxygen isotopes in shell carbonate.
Palaeogeog., Palaeoclim., Palaeoecol. 9:245-263.

Some molluscs deposit their carbonate in an isotopic equilibrium with their environment. The difference in carbon and oxygen isotopic equilibrium between carbonate and dissolved bicarbonate and water is determined by temperature. This can be applied to fossil shells. The extrapolation procedure provides a method for estimating brackishness of the water in which the molluscs lived.

MOREY, P. R. AND E. D. MOREY, 1969.
Observations on epon embedded Griffin Hill peat (Massachusetts), Two Creeks Pica (Wisconsin), Cedrus penhallowii (Sierra Nevada, California), and Callixylon (Delaware, Ohio).
Palaeontographica 125B:73-80. 3 Plates.

Distribution of lignin and the lamination of cellulose was studied in secondary tracheids of fossil woods embedded in epon. This embedding technique makes practicable the microtomy of fossil woods and other paleobotanical materials for structural studies in transmitted light microscopy. The method appears to be applicable to specimens in which organic continuity can be maintained during processing for embedment.

MURRAY, P. A. AND J. L. SHULER, 1977.
Recovery of vertebrate microfossils with tetrabromoethane.
Curator 20:15-22. 6 Figures.

Tetrabromoethane mixed with dibromoethane produces a mixture with a specific gravity just right for the heavy liquid separation of matrix and fossil material. The necessary equipment and step by step procedures to use this technique were outlined, with cost saving steps included.

NAMBUDIRI, E. M. V., W. D. TIDWELL, B. N. SMITH AND N. P. HEBBERT, 1978.
A C_4 plant from the Pliocene.
Nature 276:816-817. 1 Figure.

Specimens of petrified grasses were collected from two localities in the Ricardo Formation. These specimens show Kranz anatomy typical of C_4 plants. The fossil material was subjected to hydrofluoric acid digestion to remove the silicate material. The remainder (mainly cuticle) was then combusted at 800°C and the CO_2 collected for isotope analysis. The results were presented as $^{13}C^{0}/00$ = [(R sample - R standard) / R standard] X 1,000, where R = the mass 45 to mass 44 ratio of sample or standard. The standard was PDB (Chicago). C_4 plants have Kranz anatomy and ^{13}C values

of -9 to -16°/oo while C3 plants have ^{13}C values of -23 to 36°/oo and do not exhibit Kranz anatomy. Fossils exhibiting the Kranz anatomy gave a ^{13}C value of -13.7°/oo, indicative of C4 photosynthesis, while non-Kranz fossils gave a value of -24.6°/oo, similar to C3 plants.

The existence of the C4 photosynthetic pathway is supported by the presence in Ricardo Formation of petrified roots resembling extant panicoid plants. These fossil roots have a central stele surrounded by an aerenchymatous cortex. Air chambers in the cortex are reticulate as found in Paspalum commersonii Lamk. and P. ciliatifolium Michx; species of Paspalum are known to exhibit C4 photosynthetic pathways.

NEUMAN, R. B., 1965.
Collecting in metamorphic rocks.
In Kummel, B. and D. Raup, (eds.), Handbook of Paleontological Techniques, W. H. Freeman and Co.:159-163.

In this paper special problems were posed in collecting fossils preserved in metamorphic rocks. Recommendations were made for collecting in any rocks which have undergone diagenetic alteration (compression, decalcification, and dolomitization), contact metamorphism, deformation and regional metamorphism. The importance of collecting in metamorphosed areas was emphasized. Large collections were encouraged to make up for typically poor quality of preservation.

NEWELL, N. D., 1959.
Adequacy of the fossil record.
Jour. Paleont. 33:488-499. 2 Figures.

Author's Abstract

During the history of the Paleontological Society there have been many important developments in paleontology. In addition to steady increase in knowledge through new fossil discoveries, increasing attention is being given to ecological and evolutionary processes, and there is

growing concern with theory and principles in both the biological and geological aspects of paleontology. There is, however, a neglect of comparative morphology and taxonomy, and there are far too few expert paleontologists to cover the work to be done.

For a qualified few who recognize the challenge, opportunities are almost unlimited in paleontology for significant studies of comparative morphology, systematics, evolution, stratigraphic facies, paleoclimatology, and the general history of life. The utilitarian value of fossils as stratigraphic indicators is, and will always be, an important aspect of paleontology. But, as requirements become ever more exacting, stratigraphic paleontology calls for skilled preparation of fossils and expert knowledge of their biological nature beyond the abilities of the non-specialist.

Intensive stratigraphic studies in all parts of the world, and the development of improved methods of collecting and preparing fossils have revealed a fossil record much richer than was envisioned by the founders of the Paleontological Society. There are now substantial reasons for believing that the available record is still very incompletely known. Much remains to be learned about the processes by which organisms are preserved as fossils.

NIKLAS, K. J. AND D. E. GIANNASI, 1977.
The green fossils. 6 Figures.
Garden 5:7-17.

Fossil leaves of Japanese elm (Zelkova), Nackberry (Celtis) and elm (Ulmus), collected from the Miocene Suckor Creek Flora, demonstrated a bluish green background under reflected light. It was determined that the cuticle of the leaves was the source of the green color. This was removed with the aid of needles. The green color was shown to be due to the presence of pheophorbides, compounds which constitute chlorophyll in living plants.

Some additional organic constituents were discovered. Fatty acids, steroids, hydrocarbons, and other plant pigments were identified and confirmed that the biochemical constituency of these fossils was virtually intact. In this respect, the green leaf fossils antedote by far the preservation of Egyptian mummies or Siberian woolly mammoths.

NIKLAS, K. J. AND D. E. GIANNASI, 1978.
Angiosperm paleobiochemistry of the Succor Creek flora (Miocene) Oregon, U.S.A.
Amer. Jour. Bot. 65(9):943-953, 17 Figures.

The fatty acids and normal paraffins of fossil leaf materials were isolated and identified. Flavenoids and steroids, plus other compounds where present, were utilized to confirm identification of the leaves to, at least, genus. Intrageneric comparison among fossil and extant taxa indicates that relatively minor phytochemical differences exist, suggesting that little flavonoid and steroid evolution since post-Miocene times has occurred.

OLSEN, S. J., 1965.
Vertebrate fossil localities in Florida.
Fla. Geol. Surv. Spec. Publ. 12:1-28. 11 Figures.

In addition to listing Florida's fossil vertebrate localities, the author pointed out in some detail what fossils are and how they are found. He also mentioned where they are found and procedures for removing them. He indicated many ways in which fossils might be collected, including use of scuba equipment and dragline operations, as well as conventional methods. A step-by-step procedure showing the use of plaster and burlap was given and illustrated.

ORR, W. M., 1975.
Land use and preservation of fossil sites.
Ore. Acad. Sci. Proc.11:86. No illus.

Author's Abstract

Oregon has an impressive inventory of fossil sites. Many of these occurrences are classic in their preservation, richness, or uniqueness. The sites may be classified as vertebrate (excluding fossil man), plant fossils, invertebrate, and microfossil. Of these, the first two are among the rarest and deserving of special consideration in land use decisions. Their greatest numbers are in eastern Oregon. These sites must be identified and evaluated carefully, prior to major land decisions in these areas.

PAGE, V. M., 1960.
How to identify fossil wood, pts. 1-5.
Gems and Min. March-July 1960.

A series of popular articles explaining the structure of wood and how it is used to identify various genera was given in this paper. This is the basic information one needs to identify any wood, living or fossil.

PATTERSON, B., 1940.
Collecting fossil vertebrates.
Chicago Nat. Hist. Mus. Bull. 3:3-10. 4 Figures.

Fossil collecting requires optimistic perserverance and the ability to recognize on sight fragments of fossil bone. Once found, fossils are exposed, encased in plaster, and transported to the museum. Quarries are less glamorous than "prospecting" but yield better and more varied fossils. Exact stratigraphic information of each fossil site must be kept or the collected fossils are of little value.

PATTERSON, B., 1947.
Use of aerial photographs in fossil hunting.
Chicago Nat. Hist. Mus. Bull. 18:7. 2 Figures

Aerial photographs are invaluable in finding rock exposures in formations largely covered by grass or trees. A blind hunt for exposures could take weeks but with aerial photographs they can be found quickly. Fossil locations, old roads and trails are easily found or mapped on aerial photographs.

PAYNE, W. W., 1968.
The use of cellulose acetate film for the production of epidermal casts.
Ward's Bull.: 6-7. 2 Figures.

A method for applying cellulose acetate film to the epidermal surfaces of leaves producing an exact replica of the surface pattern was discussed.

PHEIFER, R. N. AND D. L. DILCHER, 1977.
Collecting fossil and rock specimens with a carbide tipped chain and chainsaw.
Jour. Paleont. 51:197-198. No illus.

Using a chainsaw equipped with a carbide tipped chain, fossils can be cut out of clays, marls, shales, siltstones and soft sandstones. Highly cemented sandstones and silicified limestone are too hard for the saw to cut through.

PHILLIPS, T. L., M. J. AVCIN, AND D. BERGGREN, 1976.
Fossil peat from the Illinois Basin: a guide to the study of coal balls of Pennsylvanian age.
Ill. St. Geol. Surv. Ed. Series 11:1-39. 17 Figure, 3 Plates.

A generalized discussion of the history, origin, and types of plants present in coal balls was presented. This article also included techniques and methods of studying these rather unique geologic structures.

POWELL, J. S., 1968.
Reptilian fossils and geology of uppermost Cretaceous deposits of the San Juan Basin, New Mexico.
Geol. Soc. Amer. Abstr. Programs 121:546. No illus.

Author's Abstract

Reptilian fossils collected from the uppermost Cretaceous deposits of the San Juan Basin, New Mexico, add to the biostratigraphic record of the Cretaceous-Tertiary boundary. As shown by Baltz (U.S.G.S Profession Paper 524-D) the restricted Ojo Alamo Sandstone is underlain by an unconformity which may represent the Cretaceous-Tertiary boundary. Fossils were collected from below this unconformity. Boremys grandis Gilmore, Adocus kirtlandius Gilmore, crested and noncrested hadrosaurs were collected from the Fruitland Formation. Baena nodosa Gilmore was collected from the Naashoibito Member of the Kirtland Shale. A review of the published fossil record from rocks in the San Juan Basin, and observed stratigraphic relationships, suggest that the Fruitland Formation of Bauer as well as the Naashoibito Member of Baltz are best considered units of the Kirtland Shale.

RAUP, D. M., 1975.
Taxonomic diversity estimation using rarefaction.
Paleobiology 1:333-342. 5 Figures, 3 Tables.

Author's Abstract

Benthic ecologists have successfully applied rarefaction techniques to the problem of compensating for the effect of sample size on apparent species diversity (=species richness). The same method can be used in studies of diversity at higher taxonomic levels (families and orders) in the fossil record where samples represent world-wide distributions of species or genera over long periods of geologic time.

Application of rarefaction to several large samples of post-Paleozoic echinoids (totaling 7,911 species) confirms the utility of the method.

Rarefaction shows that the observed increase in the number of echinoid families since the Paleozoic is real in the sense that it cannot be explained solely by the increase in numbers of preserved species. There has been no statistically significant increase in the number of families since mid-Cretaceous, however. At the order level, echinoid diversity may have been nearly constant since late Triassic or early Jurassic.

RAUP, D. M., 1976a.
Species diversity in the Phanerozoic; a tabulation.
Paleobiology 2:279-288. 3 Figures, 4 Tables.

Author's Abstract

On the basis of about 70,000 species citations in Zoological Record, it is estimated that about 190,000 fossil invertebrate species were described and named through 1970. A true figure may be higher because of incompleteness of the Zoological Record or lower because the estimate does not account for synonymy.

About 70% of the species were described from USSR, Europe, and North America. About 12% are Paleozoic, 28% Mesozoic, and 30% Cenozoic. In the Cambrian part of the sample, 75 percent of the species are trilobites. In the Mesozoic and Cenozoic, about 70% are either molluscs or protozoans.

When the data are normalized for absolute time, diversity (species per million years) shows a Paleozoic high in the Devonian which is approximately four-tenths of the Cenozoic level.

RAUP, D. M., 1976b.
Species diversity in the Phanerozoic an interpretation.
Paleobiology 2:298-297. 6 Figures, 1 Table.

Author's Abstract

Species diversity among fossil invertebrates of the Phanerozoic is highly correlated with volume and area of sedimentary rocks. The correlations are statistically significant at the 1% level. The relationship holds even in regions (such as Canada) where the area and volume of rock do not increase through time. These results are interpreted as indicating that the apparent number of species is strongly dependent on sampling and that many of the changes in diversity seen in the Phanerozoic are artifactual. Consequently, there is no compelling evidence for a general increase in the number of invertebrate species from Paleozoic to Recent. This conclusion applies primarily to marine organisms. Diversity may have been in dynamic equilibrium throughout much of this time.

A few intervals of the Phanerozoic have consistently fewer invertebrate species than would be predicted from the amount of sedimentary rock available for study. The Silurian, Permian, and Cretaceous stand out in this regard. This may result either from lower than normal diversity during these periods or from an unusual abundance of unfossiliferous rocks (evaporites, red beds, etc.).

REIMANN, I. G., 1952.
A new material for the paleontologist.
Jour. Paleont. 26:529. No illus.

Celastic, a plastic impregnated fabric, becomes limp and highly adhesive when dipped in its solvent, but hardens within 15 minutes to an almost indestructable film. Celastic can be used in place of plaster to jacket fragile fossil specimens. It is light weight and not bulky.

ROBISON, C. R., 1978.
A survey of the paleontological resources of southeastern Oklahoma. Oklahoma Geol. Surv. Report:1-146 (unpubl.). 15 Figures.

Modification of Author's Conclusions

Fossiliferous strata occur throughout southeastern Oklahoma. However, within Federal Coal Reserves the only significant fossil-bearing rocks are those associated with coal seams of the Pennsylvanian Hartshorne, McAlester, Savanna and Boggy Formations. These have yielded some of the best fossil collections that have been obtained from southeastern Okalhoma. Diverse plant and invertebrate fossils are the most abundant and paleontologically significant. Coal balls are present and are considered of special importance as they may contain the best preserved plant fossils from the Pennsylvanian of southeastern Oklahoma.

ROBISON, C. R. AND C. N. MILLER, 1975.
Glycol methacrylate as an embedding medium for lignitic plant fossils.
Jour. Paleont. 49:559-561.

Authors' Abstract

A procedure for infiltrating and embedding lignitic plant fossils in glycol methacrylate plastic is described. This method is significantly easier and faster than conventional celloidin embedding techniques. In contrast to material embedded in celloidin, specimens embedded in this plastic are more easily sectioned and slices less than 10 m are readily and consistently cut.

ROLFE, W. D., 1965.
Uses of infrared rays.
In Kummel, B. and D. Raup, (eds.), Handbook of Paleontological Techniques, W. H. Freeman and Co.:344-350. 2 Figures.

Many fossils, that are of the same color as the matrix or are dark or even opaque, when examined by infrared may show contrast with their matrix or may become transparent enough so that their internal structure may be seen.

SAKAMOTO, K., 1970.
Some techniques for photographing fossils.
U.S. Geol. Surv. Prof. Paper Geol. Surv. Research 700-D:230-232. Illus.

Author's Abstract

A newly designed electrically heated spray gun incorporating a variable transformer and using a filtering substance provides a safe and improved method of coating fossils with ammonium chloride sublimate. A photographic technique for producing an initial white background on photographs of megafossils provides a more accurate representation of specimens than do the conventional methods of removing the normal black background by opaquing the negative or trimming the print. This method also permits a significant saving of time over the other methods, particularly opaquing.

SANDERS, H. L., 1968.
Marine benthic diversity: a comparative study.
Amer. Nat. 102:243-282. 18 Figures, 3 Tables.

Author's Introduction

One of the major features of animal communities is their diversity, that is, the number of species present and their numerical composition. It has long been recognized that tropical regions, by and large, support a more diverse fauna than do regions of higher latitude. In the aquatic medium it is also evident that the marine habitats contain a greater

wealth of species than do brackish regions. The reasons why certain environments harbor many kinds of organisms while others support a very limited number of species are still unclear.

In the present paper, data collected from soft-bottom marine and estuarine environments of a number of differing regions will be used in a comparative study of within-habitat diversity. A new diversity measurement will be represented that is independent of sample size, and a hypothesis will be proposed to explain the observed patterns of diversity as well as to provide a framework for interpreting other diversity studies.

SAVAGE, R. J. G., 1960.
Mammals in North America.
Nature 188:200. No illus.

Paleontologists generally have not taken to washing and screening on a large enough scale, but for those who have, it has paid handsome dividends. Charles Moore obtained 30 multicuspid teeth of Microlestes by screening three tons of clay. Dr. Malcolm McKenna recovered 11,000 mammal teeth by screening rock from a formation that was almost barren of fossil material. The only limitation to this technique is the complete dissociation of all remains.

SCHAEFFER, B., 1965.
Fishes.
In B. Kummel and D. Raup (eds.), Handbook of Paleontological Techniques, W. H. Freeman and Company6: 110-118. No illus.

Factors involved in the preservation of fish skeletons as fossils include cause of death, number of fish killed, environment of death, and the number of benthic scavengers present.

Fossil fish are found most commonly in shales, less commonly in limestones and rarely in sandstones. Associated skeletons are most

common in sapropelic, fine-grained sediments and retions, although most often fragmentary remains are found.

Blind prospecting for fossil fish can be very time-consuming and discouraging. Pertinent literature should be checked and local "rock hounds" consulted before attemtps to find fossil fish are made.

Collecting tools include cold-rolled steel chisels, a shovel, crowbar, pick, Marsh pick, awls, sledge hammers, whisk brooms, and paint brushes. Delicate or fragile specimens should be hardened and placed in a plaster jacket before being removed.

SCHENCK, H. G. AND R. T. WHITE, 1942.
Collecting microfossils.
Amer. Midl. Nat. 28:424-450. 7 Figures.

Microfossils are of great value in the detailed correlation of strata and for ecologic and evolutionary studies. They need to be collected by systematic methods, with precisely located collecting stations. Practical methods for collection, labeling and stratigraphic and geographic allocation of fossiliferous samples are outlined.

SCHOPF, J. M., 1935.
The paleobotanical significance of plant structure in coal.
Ill. St. Geol. Surv. 28:106-110. 6 Figures.

Some remarkable plant structures may be obtained from bituminous coal by the various techniques now available. The methods generally practiced are: (1) thin section technique, whereby the sections are ground until they become translucent; (2) relief polishing and etching procedure; and (3) maceration, in which all the humified material is removed, leaving the chemically resistant parts free of the matrix.

SCHOPF, T. J., 1978.
Fossilization potential of an intertidal fauna:
Friday Harbor, Washington.
Paleobiology 4:261-270. 4 Tables.

Author's Abstract

How much of a living marine fauna would be reflected in the fossil record? In order to answer this, I investigated the probable fate of 169 megascopic genera of the intertidal fauna of the Friday Harbor, Washington region. Three methods were used and these give very similar results. (I) From morphologic examination, 30% of the mud fauna, 32% of the sand fauna, and 29% of the rock fauna are predicted to yield many identifiable fossils; 39% of the mud fauna, 42% of the sand fauna, and 41% of the rock fauna are predicted to yield few identifiable fossils; and the remainder are predicted to yield no fossils. (II) In actual fact, 44% of the mud fauna, 32% of the sand fauna, and 39% of the rock fauna have a fossil record (data from Treatise on Invertebrate Paleontology). (III) The 16 sediment samples which were examined yielded 29% of the total fauna. I conclude (1) that fossilization potential for the Friday Harbor intertidal fauna is largely independent of habitat and (2) that 40% of the present megascopic fauna would be (and has been!) preserved in the fossil record.

The fossil record would accurately (and preferentially) include the herbivore and filter feeding general. The reason which I postulate for this is based on the suitability of heavily calcified exoskeletons to an essentially sessile mode of life, and the lack of suitability of such skeletons for readily mobile forms. 67% of the genera which essentially rest in one place are known as fossils. In contrast, only 16 to 27% of the burrowing detritus eaters (e.g., polychaetes) and roving carnivores

(e.g., sea stars and crabs) are known as fossils. The percentage of herbivore and filter feeding genera in rocky environments is 39%, in sand 16% and in mud 34%. In the fossil record, deposits which were originally mud are likely to be most fossiliferous because (1) that environment has a high proportion of essentially sessile genera, (2) essentially sessile genera are far more likely to have a heavily calcified skeleton, and (3) few rock intertidal regions are buried.

SCHUCHERT, C., 1895.
Directions for collecting and preparing fossils.
U.S. Nat. Mus. Bull. 39:5-31. 13 Figures.

This article represents an early yet detailed account of how to collect fossils--vertebrates, invertebrates, and plants--under varying field conditions. It shows that most collecting procedures have not changed much since the time this article was written.

SEPKOSKI, J.J., JR., 1975.
Stratigraphic biases in the analysis of taxonomic survivorship.
Paleobiology 1:343-355. 8 Figures, 1 Table.

Author's Abstract

Taxonomic survivorship curves may reflect stratigraphic as well as biologic factors. The appproximately lognormal distribution of lengths of Phanerozoic time intervals produces an error in the estimation of taxonomic durations that is also lognormally distributed. As demonstrated by several simulated examples, this error may cause concave taxonomic survivorship curves to appear linear, especially if the maximum durations involved are relatively short. The error of estimation also make highly concave taxonomic survivorship curves virtually unrecognizable. Incomplete

sampling of the fossil record, on the other hand, may not be a serious problem in survivorship analysis. Simulated paleontological sampling employing a simple model suggests that survivorship curves tend to retain the original shapes even when as few as 20% of the taxa have been discovered. However, concave taxonomic survivorship curves tend to lose their concavity as efficiency of sampling declines.

SHOTWELL, J. A., 1955
An approach to the paleoecology of mammals.
Ecology 36:327-337. 4 Figures, 3 Tables.

The rapid evolution and adaptive radiation of mammals in the Tertiary period has presented an enigma to the mammalian paleontologist as to criteria for an approach to the paleoecology of mammals. Community structure cannot be approached on a morphological basis alone. Environmental situations and fossil communities must be based on quantitative analysis of quarry samples.

SHOTWELL, J. A., 1958.
Inter-community relationships in Hemphilian (Mid-Pliocene) mammals.
Ecology 39:271-282. 15 Figures, 3 Tables.

The study of inter-community relationships in fossil mammals is a first step to the understanding of community dynamics involving geologic time. The need for an effective method for delimiting communities in fossil mammals has long delayed the study of their community dynamics.

This study is an approach to distinguish, from a quarry sample, the mammals which lived together in a community and those appearing in the site but representing other communities. Limits and values of various sizes and kinds of samples are also examined.

SIGNOR, P. W., 1978.
Species richness in the Phanerozoic: an investigation of sampling effects.
Paleobiology 4:394-406. 4 Figures., 6 Tables.

Author's Abstract

Given estimates of the variation in total standing species richness through the period of the Phanerozoic, mean species duration, and the relative intensity of the samping of the fauna from each of the periods, the expected number of described species can be predicted for each period of the Phanerozoic using an analytic sampling model. This model is based on the assumption that the relative abundances of species in any geologic period can be approximated by the canonical (lognormal) species-abundance distribution.

Three commonly cited models of standing species richness (Valentine, 1973; Gould et al., 1977; Bambach, 1977) each suggest different patterns of species richness in the Phanerozoic. By assuming that sampling of the fossil record is proportionate to sediment volume, it can be shown with the sampling model that the Empirical, Equilibrium, and Species-Richness Models each predict that the number of described species will be strongly correlated with sediment volume. Equally high correlations are predicted if it is assumed that sampling is proportionate to sediment area or to paleontological interest. The correlations predicted for each of the three models are remarkably similar. The impact of sampling effects is so strong that the variations in species richness postulated by these three models are almost completely obscured. Preservational biases will probably only further obscure the relationship between the number of described species and total species richness. Therefore, it seems likely that analysis of trends in the total number of described species will be of little use in determining trends in worldwide species richness in the Phanerozoic.

Comparison of the actual patterns of variation in the number of described species and the expected numbers of described species predicted by the sampling model reveals that more species are known from the Cenozoic than would be predicted from the abundance of Cenozoic sediments or from the amount of paleontological interest in the Cenozoic. This might have resulted from the Cenozoic sediments remaining relatively free of diagenetic effects which might have destroyed the fossils entombed in the sediments.

SIMBERLOFF, D. S., 1972.
Properties of the rarefaction diversity measurement.
Amer. Nat. 106:414-418. 1 Figure, 2 Tables.

Author's Introduction

In a recent review of marine benthic diversity, Sanders (1968) pointed out that most previously used diversity indices are dependent on sample size and are consequently difficult to apply in a comparison of diversity for collections of different sizes. The rarefaction method, said to be free from this defect, was proposed and applied to an extensive series of samples of the bivalve and polychaete components of soft-bottom marine faunas. Here I demonstrate that the rarefaction method is conceptually incorrect, and functionally dependent on sample size.

SIMPSON, E. H., 1949.
Measurement of diversity.
Nature 163:688. No illus.

From Author's Introduction

The 'characteristic' defined by Yule and the 'index of diversity' defined by Fisher are two measures of the degree of concentration or diversity achieved when the individuals of a population are classified

into groups. Both are defined as statistics to be calculated from sample data and not in terms of population constants. The present purpose is to define and examine a measure of concentration in terms of population constants.

SOHL, N. F., 1965.
Collecting in unconsolidated sediments.
In Kummel, B. and D. Raup, (eds.), Handbook of Paleontological Techniques, W. H. Freeman and Co.:155-159.

This paper concentrates on collecting procedures in unconsolidated material, using for example the Ripley Formation of Coon Creek, McNairy County, Tennessee. Details of successful methods of collecting from these beds including tools necessary, sample size and hardening or coating techniques were described.

STERNBERG, R. M. AND J. G. BELDING, 1942.
Dry-peel technique.
Jour. Paleont. 16:135-136.

Introduction of the cellulose peel technique, as used by paleobotanists, is applied to the study of vertebrate and invertebrate fossils. The authors discuss some of the problems of using this method and how to correct them.

STOCKEY, R. A. AND T. N. TAYLOR, 1978.
Scanning electron microscopy of epidermal patterns and cuticular structure in genus Araucaria.
Scanning Electron Microscop. 2:223-227. 10 Figures.

From Authors' Text

Rubber replicas were made of the abaxial surfaces of leaves of the fossil Araucarites santaecrucis using KERR Permlastic dental rubber (KERR

Sybron Corp., Romulus, Michigan, 48714). A modification of this technique utilizes a coat of the light bodied base and catalyst mixture to infiltrate the small pores of the rock matrix. A dissecting needle was used to eliminate bubbles from the final cast. To hold the mold in shape a heavy bodied base and the catalyst are applied as a second coat. Replicas were peeled from the surface after hardening and allowed to dry for 24 hours to permit the evaporation of the catalyst. The replicas and the outer surface of the specimens were then coated with gold. Specimens were examined at 20KV. Since the cuticle of the leaf surface of the fossils was not present, the replicas represent a mold of the outside of the epidermis. This procedure provides an opportunity to compare the inner surface of the cuticle of living araucarian species with the replica of the fossil that represents the inner surface of the cuticle.

An examination of the rock matrix containing Araucarites santaecrucis specimens reveals rows of sunken stomata on the lower surface. A replica of the surface of a specimen shows the position of the sunken subsidiary and guard cells. The depressions in the replica represent the positions of the epidermal cells. Because the specimen has undergone some weathering, the use of replicas provides a limited amount of information of taxonomic value. Cuticles of this type are typically gymnospermous; however, insufficient detail of cell structure in these fossils prevents our assigning these leaves to a particular conifer family.

TASCH, P., 1965.
A biofacies approach to collecting nonmarine fossils.
In Kummel, B. and D. Raup, (eds.), Handbook of Paleontological Techniques, W. H. Freeman and Co.:206-211.

Molluscs (bivalves and gastropods) and athropods (crustaceans, ostracods, xiphosurans, eurypterids and insects) are identified as the

most important invertebrate fossils in the nonmarine (fresh-water) realm. Among vertebrates, fish and reptiles are those most frequently found.

A search method based upon a biological-ecological approach is discussed recommending concentrated efforts to seek a predetermined fossil by first considering what environments would likely preserve such a fossil, and then seeking rocks deposited within that environment. If the pre-search planning is correct and the environment is represented in the rocks being studied, the chances for success is considerably enhanced. Typical lithologies for preserving a variety of fresh-water forms is listed. Fresh-brackish water biofacies is also discussed. Recommendations for measuring and extending productive horizons is considered, and methods of collecting and processing bulk samples is described by the author.

TAYLOR, T. N., 1962.
The coal ball peel technique.
East Journal, Apr.-May 1962. 3 Figures.

After coal balls are collected and cut, their cut surfaces are etched in acid (HCl). These surfaces are washed and dried, and a sheet of cellulose acetate is applied after the surface has been flooded with acetone. The peel then may be pulled from the surface bringing with it the cellular detail of the petrified plant parts. This method allows for the making of many peels in a short time.

TAYLOR, T. N., 1968a.
The scanning electron microscope, a new research tool in paleobotany.
Amer. Jour. Bot. 55:722.

The scanning electron microscope (SEM) combines advantages of both light and transmission electron microscopes and is particularly adapted to the examination of solid specimens having minute surface features. In addition, the two axis rotational capability of the specimen stage of the scanning electron microscope allows one specimen to be viewed and photographed at several different angles. Its availability reduces limitation of resolution, depth of field, and maximum magnifications available imposed by light microscopy.

TAYLOR., T. N., 1968b.
Application of the scanning electron microscope in paleobotany.
Amer. Microscop. Soc. Transact. 87:510-515, 11 Figures.

The basic differences between the SEM and transmission electron microscope are explained. The article points out how the fine details on specimens normally too small to be seen can now be observed. The article further explains in general terms the various types of fossil material that can be used and their preparation for viewing with the SEM.

TEICHERT, C., 1956.
How many fossil species?
Jour. Paleont. 30: 967-999. 1 Table.

Although several people have made attempts to estimate the total number of species, animal and plant, which have lived since the beginning of life on earth, no one has tried to estimate the number of fossilizable species. This paper estimates the number of fossil invertebrate species

left to be described as between 7 to 8 million, the number of fish species as 20,000; amphibians as 2,800; reptiles as 5,500; birds as 8,600 and mammals as 13,000.

THOMAS, B. A., 1966.
The cuticle of the lepidodendroid stem.
New Phytologist 65:296-303. 5 Figures.

The value of the cuticle in the study of the stems of Carboniferous arborescent lycopods is discussed. Cuticle was prepared by macerating portions of the carbonized compression in Schulze solution followed by clearing in dilute ammonia solution. The cuticles were mounted unstained in glycerine jelly.

THURMOND, J. T., 1974.
Polystyrene solutions as fossil hardeners; save money and recycle too.
Jour. Paleont. 48:195-196. No illus.

Polystyrene and a solvent (benzone or toluene) make an excellent hardening compound. It is a clear, syrupy liquid with excellent penetrating properties, and it dries in a few minutes, does not leave a tacky surface, and does not cloud in moist weather. Acetone is not as useful. It drys slowly and becomes cloudy and sticky in moist weather. Toluene is probably the best choice as a solvent because it is inexpensive and not highly toxic or flammable. Benzene is toxic and highly flammable. Polystyrene can be purchased or styrofoam cups may be used.

TIPPER, J. C., 1976.
A method for the quantitative estimation of the faunal content of well cemented fossiliferous rocks.
Jour. Paleont. 50:175-179. 2 Figures.

Author's Abstract

The Unit Sampling Method is a binomial sampling method capable of providing consistent estimates at a known confidence level of the volumetric abundances of individual fossil groups in a fauna. Preliminary estimates of the probability of detecting each group in a single sampling unit can be converted to estimates of the group's volumetric abundance by means of correction curves, provided that the relative sizes of the fossil groups are known with respect to the size of the sampling units. The curves are obtained by an easily repeated computer simulation, and are specific to the size/frequency distribution of the sampling units.

UNWIN, M., 1951.
A new method for the impregnation of wet objects in the field.
Museums Jour., London 50:237. no illus.

The impregnation and lifting of wet objects has always been a problem. A 20 per cent weight/volume solution of polyvinyl acetate in toluol emulsified with the addition of an average of 20 per cent of a wetting agent such as "Teepol" can be used to impregnate wet objects thus obviating any warping or shrinkage due to drying out. Bones or friable rock samples can be hardened very effectively with this method.

U.S. DEPT. INTERIOR, 1978a.
Draft Environmental Statement: Development of coal resources in central Utah: Part 1, regional analysis; Part 2, site specific analysis.
Dept. Interior, U.S. Geol. Surv. Pt. 1:1-304, Pt. 2:1-84 (unpubl.). Figures and Tables.

In many ways this report is very extensive and provides needed data relevant to the developing of coal-bearing lands in southern Utah. Nevertheless, it completely omits any paleontological data concerning the areas discussed.

U.S. DEPT. INTERIOR, 1978b.
Draft Environmental Statement: Development of coal resources in southern Utah; Part 1, regional analysis, Part 2, site specific analysis.
Dept. Interior; U.S. Geol. Surv. (unpubl.). 1-365. Illlus.

Like the environmental impact study on the coal lands of southern Utah (see present bibliography), this report also largely neglects paleontology.

VALENTINE, J. W., 1970.
How many marine invertebrate fossil species? A new approximation.
Jour. Paleont. 44:410-415. 2 Figures.

Author's Abstract

Marine species diversity today appears to be more than an order of magnitude greater than the mean standing species diversity during the Paleozoic. The major cause of the inferred rise of species diversity to the present level is the provincialization of the marine biosphere due to continental drift and to increased latitudinal temperature gradients.

Using inferred levels of species diversity throughout the Phanerozoic, the total numbers of marine invertebrate species that are represented by recognizable remains can be estimated as between 342,000 and 1,543,000, a range that is significantly lower than previously suggested.

VALLENTYNE, J. R., 1955.
Sedimentary chlorophyll determination as a paleobotanical method.
Can. Jour. Bot. 33:304-313.

Chlorophyll degradation products which can be extracted from sediments with 90% acetone and which show maximal light absorption in the red end of the spectrum are collectively defined as sedimentary chlorophyll. A quantitative method is described for the determination of sedimentary chlorophyll. In any one profile the fluctuations in sedimentary chlorophyll-bearing plant tissues can be utilized, but only with some caution.

VALPEY, D., 1975.
Let us protect our fossil deposits.
Earth Science 28:286. No illustrations.

The scientific value of fossils is immeasurable. Without them we would have no knowledge of the history of life on our planet. Once fossils are destroyed nothing can be done to reproduce them. It is therefore mandatory that they be properly protected.

VAN VALEN, L., 1964.
Relative abundance of species in some fossil mammal faunas.
Amer. Nat. 98:109-116.

Author's Summary

An improved method is given for estimating the relative numbers of individuals in different taxa of extinct communities. This method is applied to nine local samples of fossil mammals. These data support the view that in mammalian communities the occupied niches are essentially adjacent and non-overlapping.

WALTON, J., 1923.
On a new method of investigating fossil plant impressions or incrustations.
Ann. Bot. 37:379-391. 2 Plates.

A method of examining the other side of fossil plant impressions or incrustations is described. A glass slide with hot balsam is applied to the fossil leaf. When cool the excess rock matrix is trimmed away. It is placed into melted paraffin wax three times. The wax is removed from the matrix and the entire slide is placed into HF until rock is dissolved away. The leaf is left embedded in the balsam on the slide.

WALTON, J., 1935.
An application of infra-red photography to paleobotanical research.
Nature 135:265. 1 Figure.

Transfer preparations of fossil plants provide the paleobonatist with plant remains separated from rock matrix. Whereas some of these preparations are translucent under transmitted light, others are opaque. These apparently opaque fossil remains are translucent when exposed to infra-red sensitive film. This method may be effective in coal petrology.

WALTON, J., 1951.
Notes on the preparation and permanence of peel sections.
Troisieme congres. pour L'advancement des E'tude de stratigraphie et de geologie du Carbonifere Tome II:651-653.
2 Figures.

The author discussed the various methods of producing peels. He included the advantages of cellulose acetate over nitrocellulose, the use of the leveling plate and the use of albumen gelatine in transferring peel sections.

WARD'S NATURAL SCIENCE ESTABLISHMENT, 1950.
First steps in field collecting of fossils.
Ward's Nat. Sci. Bull. 23:75-76. 4 Figures.

Simple fossil collecting tools, including a 3 pound hammer, a World War I trench pick, an iron bar, and a railroad pick were mentioned and the type of rock for which each tool is useful was described.

Separating specimens by locality and properly labeling them was encouraged. Collecting bags and containers were mentioned in this short article for amateurs.

WATSON, J. AND K. L. ALVIN, 1976.
Silicone rubber casts of silicified plants from the Cretaceous of Sudan.
Palaeontology 19:641-650. 3 Plates.

Low viscosity silicone rubber was used to obtain casts showing fine detail of exposed surfaces of silicified plant fragments which can then be studied by scanning electron microscopy. The material used known as Silflo has several distinct advantages over latex rubber. It is very quick to use; there is no water in the mixture and therefore no damage to clay matrix; there is no detectable shrinkage over a period of time; and air bubble problems are reduced to a minimum.

WILSON, L. R., 1945.
Application of paleoecological method to an early Tertiary coal seam. Geol. Soc. Amer. Bull. 56(12)pt. 2:1212.

Author's Abstract

Samples of coal were collected from five exposures of a single coal seam near Wamsutter, Wyoming. This coal is of Green River age. The samples were macerated and studied microscopically for plant spores and pollen. Tertiary coals contain many genera of modern plants. The species are probably all extinct, but ecological inferences can be drawn from the present distributions of the genera. Almost 200 species of microfossils were observed in the Wamsutter coal. Counts of 1000 fossil spores and pollen from each collection were made. These give some idea of the composition of the Green River vegetation in the vicinity of the Red Desert of Wyoming. The various species of spores and pollen do not appear in the same abundance throughout the vertical extent of the seam. This fact suggests a change in the vegetative cover which might be related to topographic development or climatic variation during Green River time. In general the fossils depict a warm moist climate with phases of semiaridity. Several species of pollen suggest an adjacent topography of considerable relief. There is fair ecological correlation between the five exposures of coal. If the samples had been collected in short contiguous sections instead of at intervals through the seam, correlation of levels might have been more than approximate. With some modification the paleoecological method may be applied to Tertiary coals.

WILSON, L. R., 1966.
Stain technique for studying silicified wood sections.
Okla. Geol. Notes 25:274-276. 1 Plate

The use of stained Hoyer's solution as a mountant for colorless silicified wood sections results in better morphological preparations. The mixture of Hoyer's solution and Bismark brown Y powder produces a dark reddish-brown solution adequate for the studying of most silicified wood sections.

WILSON, L. R., 1969.
Fossil Wood.
Turtox News 47:15-17. 4 Figures.

The article is about standard thin sectioning techniques as they apply to the study of petrified woods.

WILSON, L. R., 1971.
Notes on the uses of stains for colorless silicified wood.
Jour. Paleont. 45:912-913.

The author compares his Hoyer's solution technique with methods described by other workers.

WILSON, R. L., 1965.
Techniques and materials used in the preparation of vertebrate fossils.
Curator 8:135-143. 1 Figure.

From Author's Text

In the past several years certain techniques in the preparation of vertebrate fossils have been developed to facilitate the disaggregation of a large volume of fossiliferous sediment and the preservation of extremely

fragile fossil material. This report provides information on three basic materials used: glyptal, certain polyvinyl adhesives, and kerosene. For five years these products have aided in and solved the majority of the problems met in the preparation of fossils at the University of Oregon.

WOLFE, J. A., 1971.
Tertiary climatic fluctuations and methods of analysis of Tertiary floras.
Palaeogeog., Palaeocl., Palaeoecol. 9:27-57.

Author's Abstract

On theoretical grounds, an analysis of the physiognomy of a Tertiary leaf assemblage is more direct and reliable than a circuitous floristic analysis in assigning thermal regimes to fossil assemblages. Using primarily foliar physiognomy and secondarily floristic composition, it can be shown that: (1) some middle latitude Tertiary assemblages probably lived under meteorologically tropical climates; (2) a major and rapid climatic deterioration occurred in the Oligocene; and (3) a major climatic fluctuation probably occurred in Late Eocene.

These analyses thus substantiate the conclusions of several other paleobotanists regarding climatic fluctuations. Recent criticisms of these analyses are shown to be invalid and based largely on misinterpretations.

WOLFF, R. G., 1975.
Sampling and sample size in ecological analyses of fossil mammals.
Paleobiology 1:195-204. 5 Figures, 1 Table.

Author's Abstract

Analysis of several thousand mammalian fossils from late Pleistocene sediments in California provide data on sampling in mammalian paleoecology. Recovery of bones and teeth from the screenwashed bulk sediment sample residue is considered nearly total. Neither surface collecting alone, nor small bulk samples provide satisfactory quantitative data on original community structure or postmortem alterations in community organization. Minimum sample size for the analysis of diversity is discussed. Diversity and size-trophic ratios of the total identifiable mammalian component of this fauna (N = 1222) are similar to those expected in living communities, and therefore suggest adequate sampling, and minimally biased samples.

WOOD, J. M. AND K. L. SEGROVES, 1963.
Method for collecting coal and shale samples.
Micropaleont. 9:340. 1 Figure.

Spore and pollen researchers can obtain rock samples from outcrops of coal and shale by using a carpenter's brace and bit. The drill bit size can be adjusted for gross sampling or for sampling over short vertical distances. A collecting plate can be constructed to collect the sample and avoid contamination.

YEN, T. C., 1949.
Review of the Lower Cretacous fresh-water molluscan faunas of North America.
Jour. Paleont. 23: 465-470. No illus.

Lacustrine molluscs from the Atlantic Coastal Plain, the northern Rocky Mountain region in Montana, Idaho, South Dakota and Wyoming, Eureka, Nevada area, and southern Alberta were identified. Correlations of these rocks with European stratigraphic units were proposed.

ZEITNER, J. C., 1968.
Collecting vertebrate fossils.
Gems and Min. 369:18-21, 52-54. 5 Figures.

This article, for amateur collectors, explains general collecting techniques, including what tools to use, how to bandage a specimen with plaster, and how to harden fragile bones. Laboratory preparation techniques were also mentioned.

ZEUNER, F. E., 1946.
Dating the past: an introduction to geochronology.
London, Metheun and Co., Ltd., 444 p. 101 Figures, 24 Plates.

This book is concerned with the various methods of dating the past. The two methods emphasized are tree ring dating and varve dating. Investigation of past variations in climate, especially in rainfall, as derived from annual rings in trees, was also discussed.

ANNOTATED BIBLIOGRAPHY OF THE PALEONTOLOGY OF THE SAN JUAN BASIN

ALBUQUERQUE DISTRICT, BUREAU OF LAND MANAGEMENT, 1978.
Draft Environmental Statement, Star Lake - Bisti Regional Coal.
U.S. Dept. Interior, Bureau of Land Management (3 parts, unpubl.)

This report is an environmental impact study of the Star Lake - Bisti Coal region in the San Juan Basin of New Mexico. A wide variety of possible impacts were discussed including paleontological ones. Fossil sites within the proposed area of future development and their significance were reported.

ALLEN, J. E. AND R. BALK, 1954.
Mineral resources of Fort Defiance and Tohatchi quadrangles Arizona and New Mexico.
New Mexico Bur. Mines Min. Res. Bull. 36:1-192.

This is a fairly complete report on the Fort Defiance-Tohatchi quadrangles on the western side of the San Juan Basin. The authors only mentioned fossils associated with certain formations, such as Gryphaea newberryi and plant fragments from the Dakota Sandstone or fossiliferous beds (shark teeth, pelecypods) represent the "Satan Tongue of the Mancos Shale." They mentioned a species of a huge camel presumably of late Pliocene age that was collected from the Chuska Formation 5-1/2 miles northwest of Jedito. Camel tracks were also noted from a sandstone southwest of Jedito.

ANDERSON, R. Y., 1959.
Floral and faunal changes at the Cretaceous-Tertiary boundary, San Juan Basin, New Mexico.
New Mexico Geol. Soc. Guidebook, 10th Field Conf.:159.

Author's Abstract

The Picture Cliffs, Fruitland, Kirtland, Ojo Alamo, Animas, and Nacimiento formations are all in facies contact with the upper part of the marine Lewis shale along the eastern side of the San Juan Basin.

The Cretaceous-Tertiary boundary intersects this transitional and varied sequence creating a unique opportunity to correlate changes in major fossil groups.

The most significant change in the pollen and spore assemblage occurs between the Ojo Alamo sandstone and the Kirtland shale, with a considerable influx of more temperate genera. The Ojo Alamo probably would be considered Paleocene from similarity to the Nacimiento flora and other Paleocene miospore floras in the Rocky Mountain area. The last dinosaurs, however, continued into the more temperate and variable Ojo Alamo environment before extinction and the significant change in the vertebrate record occurs in the overyling Paleocene Nacimiento formation.

The upper part of the Lewis shale contains a newly discovered foraminiferal fauna and preliminary work suggests the presence of at least three distinct faunal zones. The lower two zones contain ammonites and are Cretaceous in age. The upper zone may be Cretaceous or Paleocene in age. It seems to be present only to the north of the Ojo Alamo pinchout, and may be correlative with the Ojo Alamo sandstone.

The uppermost part of the Lewis shale, above the last occurrence of foraminifera, contains a flora of intermediate Cretaceous-Paleocene aspect and abundant paralicbrackish hystrichospherids and dinoflagellates. This unit may also be correlative with the Ojo Alamo sandstone and perhaps with the basal part of the Paleocene Nacimiento formation.

ANDERSON, R. Y., 1960.
Cretaceous-Tertiary palynology, eastern side of the San Juan Basin, New Mexico.
New Mexico Bur. Mines Min. Res. Mem. 6:1-59. 11 Plates, 1 figure.

From Author's Abstract

Early studies of vertebrate and plant fossils in the San Juan Basin confirmed a late Cretaceous age for the Kirtland shale and a Tertiary age for the Nacimiento Formation, but resulted in disagreement over the age of the intervening Ojo Alamo Sandstone. Dinosaur evidence indicated a late, but not latest, Cretaceous (Montanan) age, but fragmentary plant megafossils suggested a Tertiary age. Pollen and spore florules collected from within, above, and below the formation tend to confirm a Tertiary age and reflect the environmental changes that accompained local uplift to the Cretaceous-Tertiary transition.

ARMSTRONG-ZIEGLER, J. G., 1978.
An aniliid snake and associated vertebrates from the Campanian of New Mexico.
Jour. Paleont. 52:480-483. 1 Figure, 1 Table.

Author's Abstract

A new species of aniliid snake is described from the Upper Cretaceous Fruitland Formation thirty miles southwest of Farmington, New Mexico. It is represented by a single complete vertebra from one of four sites where more than 7,000 fossil vertebrates were recovered in screen-washing operations. Associated vertebrates include sharks, bony fishes, amphibians, reptiles and mammals similar to those obtained from a number of other Late Cretaceous sites in the Rocky Mountain region.

BALTZ, E. H., JR., 1967.
Stratigraphy and regional tectonic implications of part of Upper Cretaceous and Tertiary rocks, east-central San Juan Basin, New Mexico.
U.S. Geol. Surv. Prof. Paper 52:1-101.

This is a detailed stratigraphic study of the San Jose Formation. Four members were proposed--Cuba Mesa Member, Regina Member, Llaves

Member, Tapicitos Member. These are mapped throughout a large area along the eastern side of the San Juan Basin.

BALTZ, E. H. AND S. R. ASH, 1964.
The Cretaceous-Tertiary boundary, San Juan Basin, New Mexico.
New Mexico Geol. Soc. Guidebook, 15th Field. Conf.:185. No illus.

Authors' Abstract

A restudy of the type region of the Ojo Alamo Sandstone indicates that the upper conglomeratic sandstone rests on a deeply channeled erosion surface cut in the medial dinosaur-bearing shale which is a persistent unit, rather than being a lens as reported by Bauer. The upper conglomeratic sandstone also intertongues with the Nacimiento Formation and contains a microflorule identical to a microflorule from the beds of the Nacimiento that contain Puercan mammals. Thus, the upper part of Bauer's Ojo Alamo is Paleocene and rests unconformably on the middle part which is Late but not latest Cretaceous. These facts indicate that the Ojo Alamo Sandstone should be redefined, and concepts on the nature and stratigraphic position of the Cretaceous-Tertiary boundary in the San Juan Basin should be revised.

BALTZ, E. H., S. R. ASH AND R. Y. ANDERSON, 1966.
History of nomenclature and stratigraphy of rocks adjacent to the Cretaceous-Tertiary boundary western San Juan Basin, New Mexico.
U.S. Geol. Surv. Prof. Paper 524-D:1-23.

This paper summarizes the history of the stratigraphy of this region. The Ojo Alamo Sandstone is restricted to the upper conglomerate of Bauer and the Naashoibito Member of the Kirtland Shale is defined.

BAUER, C. M., 1916.
Contributions to the geology and paleontology of San Juan County, New Mexico, part 1. Stratigraphy of a part of the Chaco River Valley.
U.S. Geol. Surv. Prof. Paper 98:271-278.

This early paper sets forth the principal features of the stratigraphy in the western part of the San Juan Basin. It describes the succession of strata irrespective of possible correlations and attempts to establish a type section for the formations exposed.

BAUER, C. M. AND J. B. REESIDE, JR., 1920.
Coal in the middle and eastern parts of San Juan County, New Mexico.
U.S. Geol. Surv. Bull. 716:155-248.

This report deals with coals in the various coal bearing formations of the San Juan Basin. Fossils are mentioned in summarizing the age of these formations.

BEAUMONT, E. C., AND J. W. SHOEMAKER, 1974.
Upper Cretaceous coal in the Cuba-La Ventana--Torreon area, eastern San Juan Basin, New Mexico.
New Mexico Geol. Soc. Guidebook, 25th Field Conf:329-332.

This article is a report on the coals located in a triangle formed by Cuba, La Ventana and Torreon Trading Post. Coal mining was active in this area during the 1920s and 30s with minor activity until the 1960s. Major resources, consisting almost entirely of coal beyond economic stripping depths, exist in the region. The coal-bearing strata are within the Menefee and Fruitland formations.

BROWN, B., 1910.
The Cretaceous Ojo Alamo beds of New Mexico with description of the new dinosaur genus Kritosaurus.
Amer. Mus. Nat. Hist. Bull. 28:267-274. 7 Figures, 3 plates.

A new locality for dinosaurs near Ojo Alamo, in northern New Mexico, was reported to the American Museum in 1902. In 1904, Brown secured a small but interesting collection of fossils. This represented a fauna distinctly older than the Lance Creek Beds or Ceratops Zone and Hell Creek Beds of the Laramie Cretaceous. In this fauna turtle bones were frequently found associated with dinosaur bones. The most important fossil from this locality is a skull, lower jaws and atlas of a hitherto undescribed genus and species of the family Trachodontidae, Kritosaurus navajovius (type specimen - AMNH No. 5799). These fossils come from shales about one mile south of the store at Ojo Alamo.

BROWN, B., 1914.
Cretaceous-Eocene correlation in New Mexico, Wyoming, Montana, Alberta.
Geol. Soc. Amer. Bull. 25:355-380. 2 Figures.

The author used floral and faunal evidences, mostly vertebrates, to show Cretaceous-Early Tertiary correlations in New Mexico, Wyoming, Montana and Alberta. Taxa were given at the genus and species level. The Puerco [Nacimiento] Formation and Ojo Alamo Beds represent the only stratigraphic units mentioned for New Mexico. Fossils listed from these beds were few. Only a fish and some reptiles were given.

BROWN, R. W., 1962.
Paleocene flora of the Rocky Mountains and Great Plains.
U.S. Geol. Surv. Prof. Paper 375:1-119.

This report is an overview of fossil plants from the Paleocene epoch of the western United States. Brown synonymized many previously described species

and formulated a tentative list of 170 recognizable species for this time period in this region. He mentioned several localities in the San Juan Basin.

BRUES, C. T., 1936.
Evidences of insect activity preserved in fossil wood.
Jour. Paleont. 10:637-643. 6 Figures.

Two specimens of fossil wood containing excavations made by ants (Camponotus?) from a roadside locality approximately 50 miles south of Aztec, New Mexico on the highway between Aztec and Cuba, were described and illustrated. The fossils were from either the Torrejon or Puerco Formations [?Nacimiento Formation] of Paleocene age.

BUTLER, R. F., E. H. LINDSAY AND L. L. JACOBS, 1976
Paleomagnetic polarity stratigraphy through the Cretaceous-Tertiary boundary, San Juan Basin, New Mexico.
Amer. Geophys. Union Trans. (E.O.S.) 57:902. No illus.

From Authors' Abstract

Terrestrial deposits in the San Juan Basin of New Mexico contain a very complete late Cretaceous through early Tertiary non-marine sedimentary sequence. Paleomagnetic samples were collected at approximately 120 sites (3 samples/site) in a stratigraphic sequence through the late Cretaceous Fruitland, Kirtland, and Ojo Alamo formations and into the overlying Nacimiento Formation of early Tertiary age. Many vertebrate faunal levels are known from these strata, including dinosaur beds and the type Puercan (early Paleocene) Land Mammal Age. The resulting polarity stratigraphy through the Cretaceous-Tertiary boundary is of sufficient length and character to allow correlation with the marine

magnetic anomaly time-scale. The Cretaeous-Tertiary boundary, recognized on the highest stratigraphic occurrence of dinosaurs and the appearance of diversified placental mammals, occurs near the top (young side) of marine magnetic anomaly 29. This places the boundary slightly younger than, but very close to, the Cretaceous-Tertiary boundary in the marine sequence at Gubbio, Italy, studied by Lowrie et al. (1976).

BUTLER, R. F., E. H. LINDSAY, L. L. JACOBS AND N. M. JOHNSON, 1976. Preliminary report on magnetic stratigraphy of Cretaceous-Paleocene continental deposits in the San Juan Basin, New Mexico. Amer. Geophys. Union Trans. (E.O.S.) 57:238. No illus.

From Author's Abstract

Terrestrial deposits in the San Juan Basin of New Mexico contain well exposed, undistorted, flat-lying sediments and well documented vertebrate faunas for the late Cretaceous-early Tertiary interval in North America. The sedimentary sequence of predominantly siltstones and claystones contains type faunas for Puercan (early Paleocene), Torrejonian (middle Paleocene), and Tiffanian (late Paleocene) Land Mammal Ages. However, these type faunas occur in isolated outcrops within the San Juan Basin, and the stratigraphic relationships between the type localities cannot be determined on the basis of lithologic correlation alone. Thus, we are attempting to employ paleomagnetic polarity stratigraphy as a correlation technique. Successful stratigraphic correlation between two sections of Torrejonian age indicates that paleomagnetic polarity is a viable stratigraphic correlation technique for the late Cretaceous-early Tertiary terrestrial deposits of the San Juan Basin.

BUTLER, R. F., E. H. LINDSAY, L. L. JACOBS, AND N. M. JOHNSON, 1977.
Magnetostratigraphy of the Cretaceous-Tertiary boundary in the San Juan Basin, New Mexico.
Nature 267:318-323. 6 Figures.

Authors' Abstract

Magnetostratigraphy of a terrestrial sedimentary sequence in San Juan Basin reveals that the Cretaceous-Tertiary boundary, recognized by the highest stratigraphic occurrence of dinosaurs, is younger than the midpoint of marine magnetic anomaly 29. This boundary is slightly younger than, but very close to, the Cretaceous-Tertiary boundary in marine sedimentary sequence at Gubbio, Italy, which has recently been proposed as the magnetostratigraphic type section for the Upper Cretaceous and Palaeocene.

BUTLER, R. F. AND L. H. TAYLOR, 1977.
A middle Paleocene paleomagnetic pole from the Nacimiento Formation, San Juan Basin, New Mexico.
Geol. Soc. Amer., Abstr. Programs 9:918. No illus.

Author's Abstract

A total of 282 oriented samples were collected at 94 sites in a 250 m thick section of the Nacimiento Formation at Kutz Canyon (36.5°N, 252.0°E) in the San Juan Basin of northwestern New Mexico. The section is dominantly continental claystones and siltstones. Vertebrate fossils of Torrejonian (Middle Paleocene) Land Mammal Age occur at several localities near the midpoint of the sample section. Alternating-field (AF) demagnetization to a peak field of 300 oe was sufficient to remove secondary viscous magnetization from the primary depositional remanence (DRM). Three magnetozones in stratigraphic superposition are observed in the section with 52 sites showing

reversed polarity and 42 sites of normal polarity. The stability of the primary DRM and efficiency of the AF demagnetization is evidenced by the observation that the mean directions for the normal and reversed sites are antiparallel to within 2°. The overall mean direction of magnetization calculated by averaging antipoles of directions from reversed sites with directions from the normal site yields: I = 51.9°, D = 344.0°, with $\alpha_{95\%}$ = 3.3°. Calculation of the paleomagnetic pole yields λ_p = 76.3°N, ϕ_p = 149.8°E (dp = 3.1°, dm = 4.5°). The averaging of the geomagnetic field direction through the 3 polarity intervals in this section along with the excellent age control of the Nacimiento Formation provides a very well-determined Middle Paleocene paleomagnetic pole position for the Colorado Plateau.

CHAMBERLAIN, C. K., 1971.
Biogenic mounds in the Dakota Sandstone of northwestern New Mexico. Jour. Paleont. 45(4):641-644. Figures.

Author's Abstract

Biogenic fecal and spoil mounds attributed to Callianassa-like animals but possibly to some worm-form are profuse on a bedding plane in the Dakota Sandstone of northwestern New Mexico. These mounds, tentatively referred to Chomatichnus wegberensis, Donaldson & Simpson, occur in a sequence of sandstones replete with the shallow water fossils Ophiomorpha and Thalassinoides and the oyster Pycnodonte newberryi. The Chomatichnus assemblage apparently was preserved in a lagoon sheltered from direct wave agitation.

CLEMENS, W. A., 1973.
The roles of fossil vertebrates in interpretation of Late Cretaceous stratigraphy of the San Juan Basin, New Mexico.
Cretaceous and Tertiary rocks of the southern Colorado Plateau, Four Corners Geol. Soc. Mem., 154-167.

Sedimentary, non-marine, Late Cretaceous rocks are exposed in the Chaco River drainage system. Some areas contain rich concentrations of fossil vertebrates. These vertebrates have helped determine the age of many of these units. The Hunter Wash local fauna (Fruitland and Kirtland Formations) from near Bisti Trading Post correlates roughly with the type Lance local fauna, parts of the Edmonton Formation, Judith River Formation and the Milk River Formation to the north.

COBBAN, W. A., 1951.
Scaphitoid cephalopods of the Colorado group.
U.S. Geol. Surv. Prof. Paper 239:1-42.

Scaphitoid ammonites are abundant in some rocks of the Colorado group. On the south and east side of the San Juan Basin species of Scaphites are present in the Mancos Shale.

COBBAN, W. A., 1969.
The Late Cretaceous ammonites Scaphites leei Reeside and Scaphites hippocrepis (DeKay) in the western interior of the United States.
U.S. Geol. Surv. Prof. Paper 619:1-29. 5 Plates.

Scaphites leei and S. hippicrepis have been found in many areas of Montana, Wyoming, Colorado, South Dakota, Utah and New Mexico. Apparent sexual dimorphism is present in these two forms.

COBBAN, W. A., 1973.
Significant ammonite finds in uppermost Mancos Shale and overlying formations between Barker Dome, New Mexico, and Grand Junction, Colorado. Cretaceous and Tertiary rocks of the southern Colorado Plateau, Four Corners Geol. Soc. Mem. 148-153.

The author collected the following from near Baker Dome:

Lewis shale: Baculites asperiformis, B. perplexus, Didymoceras, n. sp., D. nebrascense.

Pictured Cliffs Sandstone: Didymoceras cf D. cheyennense. Baculites gregoryensis occurs along the east side of the San Juan Basin, probably in the Lewis Shale.

COBBAN, W. A., 1977a.
Characteristic marine molluscan fossils from the Dakota Sandstone and intertongued Mancos Shale, west-central New Mexico.
U.S. Geol. Surv. Prof. Paper 1009:1-30.

Molluscan fossils are abundant in marine rocks of early Late Cretaceous age (Cenomanian) on the south and southeast flanks of the San Juan Basin in northwestern New Mexico. Most specimens are found in silty limestone concretions, in calcareous siltstone an sandstone concretions, and in very fine-grained sandstone and siltstone beds. The upper part of the Oak Canyon Member and the Paguate Sandstone Tongue of the Dakota Sandstone contain the greatest variety of fossils.

COBBAN, W. A., 1977b.
Fossil mollusks of the Dakota Sandstone and Intertongued Mancos Shale of west-central New Mexico.
New Mexico Geol. Soc. Guidebook, 28th Field Conf.:213-220.

Marine fossils including bivalves, gastropods and ammonoids from 28 localities in the Dakota Sandstone and Mancos Shale of west-central New

Mexico were identified and illustrated. The assemblage is considered Cenomanian in age. The Oak Canyon Member yielded 34 species of bivalves, 11 species of gastropods, and 5 species of ammonoids. The Cubero Sandstone Tongue produced 19 bivalve species, 1 gastropod species and 2 ammonoid species. The Clay Mesa Shale Tongue contained only nine species of bivalves and three ammonoid species. The Whitewater Arroyo Shale Tongue produced 19 species of bivalves, two species of gastropods and eight species of ammonoids. Collections from the Twowells Sandstone Tongue contained 21 species of bivalves, 2 species of gastropods and 5 species of ammonoids.

COCKERELL, T. D. A., 1915.
Tertiary mollusca from New Mexico and Wyoming.
Amer. Mus. Nat. Hist. Bull. 33:101-107.

Viriparus trochiformis and Campeloma calamodontis (n. sp.) are two gastropods reported from the San Jose formation near Ojo San Jose.

COLBERT, E. H., 1950.
Mesozoic vertebrate faunas and formation of northern New Mexico.
Soc. Vert. Paleont. Guidebook, 4th Field Conf.:57-73.

There are two general areas in northern New Mexico where Mesozoic vertebrates can be found. One is the drainage of the Chama River where the Triassic, Jurassic and Cretaceous are exposed and the other are exposures of Cretaceous sediments in the San Juan Basin. The author discussed the Chinle fauna, mentioned fishes from the Todilto Formation, and stated that vertebrate fossils are not present in the Morrison Formation in New Mexico, although bones may be eventually found after a diligent search. The fossil content of the Cretaceous formations are discussed in a general manner and the faunas from the Fruitland, Kirtland and Ojo Alamo formations are listed.

COPE, E. D., 1874.
Notes on the Eocene and Pliocene lacustrine formations of New Mexico, including descriptions of certain new species of vertebrates.
U.S. Geol. Surv. West of the 100th Meridian, Ann. Rept. (Wheeler Survey):115-130.

This is the original description of Cope's fieldwork in New Mexico. Twenty-five new species of fossil vertebrates, mostly mammals, from the San Jose Formation were described.

COPE, E. D., 1875a.
The Vertebrata of the Cretaceous formations of the West.
U.S. Geol. Survey Terr. (Hayden) Rept. 2:1-303.

A summary, listing the taxa described in Cope (1974) and their descriptions, with some emendation and elaboration is given in this article.

COPE, E. D., 1875b.
Systematic catalogue of vertebrata of the Eocene of New Mexico collected in 1874.
U.S. Geol. Surv. West of the 100th Meridian (Wheeler Survey):1-37.

With some minor revisions, this article is essentially a reprint of Cope (1874) and (1875a).

COPE, E. D., 1875c.
Reports on the geology of that part of northwestern New Mexico examined during the field season of 1874.
U.S. Geol. Surv. West of the 100th Meridian, Ann. Rpt. (Wheeler Survey):61-97.

In this paper a synopsis of the itinerary of the Wheeler Survey is given which includes some observations on San Juan Basin geology.

COPE, E. D., 1876a.
On the supposed carnivora of the Eocene of the Rocky Mountains.
Acad. Nat. Sci. Phila. Proc. 1875:444-448.

The Creodonta, primitive early Tertiary carnivores whose fossils come from the Rocky Mountain region, were discussed. Their distribution which includes the San Juan Basin was summarized.

COPE, E. D., 1876b.
On a gigantic bird from the Eocene of New Mexico.
Acad. Nat. Sci. Phila. Proc. 1876:10-11.

Diatryma gigantea, a giant flightless bird, is described from a partial tarsometatarsus found in the San Jose Formation in the San Juan Basin, New Mexico.

COPE, E. D., 1876c.
On the taeniodonta, a new group of Eocene Mammalia.
Acad. Nat. Sci. Phila. Proc. 1876:39.

The order Taeniodonta was first proposed in this publication. Its diagnostic characters were discussed.

COPE, E. D., 1876d.
On the geologic age of the vertebrate fauna of the Eocene of New Mexico.
Acad. Nat. Sci. Phila. Proc. 1876:63-66.

Comparison and correlation of the Eocene fauna of New Mexico was made with others of the Rocky Mountain region and of Europe.

COPE, 1876e.
On some supposed lemurine forms of the Eocene Period.
Acad. Nat. Sci. Phila. Proc. 1876:88-89.

This paper consists of a discussion of the affinities of Cope's genus Tomitherium (type from the San Juan Basin) and the proposal of the new order "Bunotheria."

COPE, E. D., 1877.
Report upon the extinct vertebrates obtained in New Mexico by parties of the expedition of 1874.
U.S. Geographical Surveys West of the 100th Meridian (Wheeler) 4:1-370. 51 Plates.

As an extensive report dealing with the geology and vertebrate paleontology of northwestern New Mexico, this article represents some of the earliest work on the fossil vertebrates of the San Juan Basin. From these findings came the basic geological and paleontological foundation upon which many later articles are based. Many new taxa were named from fossils found on this expedition.

COPE, E.D., 1881a.
Mammalia of the lower Eocene beds.
Amer. Nat. 15:337-338. No illus.

This is apparently the first report of fossil vertebrates from the "Puerco" [Nacimiento] Formation. Both turtles and mammals were cited, with only the latter being identified. Two new genera and species (Periptychus carinidens, Deltatherium fundaminis) were named and briefly described.

COPE, E. D., 1881b.
On some Mammalia of the Lowest Eocene beds in New Mexico.
Amer. Philos. Soc. Proc. 19:484-495. No illus.

In this paper the author described several new genera and species of mammals from the San Juan Basin in New Mexico. Included new taxa were Mesonyx navajovius, n. sp. (type - ? lower jaw with dentition), Periptychus carinidens, n. gen. et sp. (type - ? lower jaw with incomplete dentition), Triisodon quiverensis, n. gen. et sp. (type - lower jaw with incomplete dentition), Deltatherium fundaminis, n. gen. et sp. (type - two maxilla with nearly complete dentition), Conoryctes comma, n. gen. et sp. (type - lower jaw with incomplete dentition), Catathlaeus rhabdodon, n. gen. et sp. (type - ? cranial material including dentition), Anisonchus sectorius, n. gen. et sp. (type - upper and lower dental material), Mioclaenus turgidus, n. gen. et sp. (type - ? lower jaw with dentition), M. subtrigonus, n. sp. (type - incomplete skull with dentition), Phenacodus puerensis, n. sp. (type - upper and lower dentition), P. zuniensis, n. sp. (type - lower jaws of two individuals), Protogonia subquadrata, n. gen. et sp. (type - upper cheek teeth) and Meniscotherium terraerubrae, n. sp. (type - dentition of several individuals).

COPE, E. D., 1882a.
Contributions to the history of the Vertebrata of the lower Eocene of Wyoming and New Mexico made during 1881.
Amer. Philos. Soc. Proc. 20:139-197. 1 Map.

Most of the vertebrate fossils discussed in this article are from Wyoming. This fauna was compared to that from the San Jaun Basin in New Mexico. Several new taxa from the latter locality were described. These

include Psittacotherim aspasiae, n. sp. (type - lower jaw of a subadult with partial dentition), Sarcothaustes antiquus, n. gen. et. sp. (type - M^2 and M^3 incomplete lower jaws with partial dentition of one individual), Champsosaurus puercensis, n. sp. (type - three dorsal and four caudal vetebrae of one individual) and C. sapoensis, n. sp. (type - vertebrae).

COPE, E. D., 1882b.
Synopsis of the Vertebrata of the Puerco Eocene epoch.
Amer. Philos. Soc. Proc. 20:461-471. No illus.

This paper contains a listing of all vertebrate fossils discovered to date in the early Tertiary sediments of the San Juan Basin. Those listed were considered sufficient to characterize the Puerco fauna. Four new species were added to this fauna in this paper, Hyopsodus acolytus (type - upper and lower molars of two individuals), Didymictis Haydenianus (type - left maxillary and dentary with incomplete dentition), Haploconus xiphodon (type - dentary with partial dentition and Meniscotherium tapiacitis (type - lower jaw with partial dentition).

COPE, E. D., 1882c.
A new genus of Tillodonta.
Amer. Nat. 16:156-157. No illus.

This short report contains the description of a new genus and species of tillodont (Psittacotherium multifragum) from the Puerco (Nacimiento) Formation. The type is apparently a lower jaw with dentition.

COPE, E. D., 1882d.
Two new genera of the Puerco Eocene.
Amer. Nat. 16:417-418. No illus.

The two new genera and species described in this report, Haploconus lineatus and Pantolambda bathmodon, evidently come from the Puerco (Nacimiento) Formation in northwestern New Mexico. H. lineatus is based on several specimens including upper and lower dentitions. Although unclear, it appears that a second species, H. angustus had been previously assigned to Mioclaenus. The type of Pantolambda bathmodon is a lower jaw with partial dentition.

COPE, E. D., 1882e.
A new genus of Taeniodonta.
Amer. Nat. 16:604-605. No illus.

A new genus and species assigned to the order Taeniodonta actually represents a new multituberculate, Taeniolabis sulcatus (type - a single tooth). Evidently, the type specimen comes from the Nacimiento beds of New Mexico.

COPE, E. D., 1882f.
New marsupials from the Puerco Eocene.
Amer. Nat. 16:684-686. No illus.

Three new species and one new genus assigned to the marsupials, were reported from the Puerco (Nacimiento) Formation of New Mexico. The new taxa include Polymastodon taoensis, n. gen. et sp. (type - lower dentition), Ptilodus trovessartianus, n. sp. (type - three P_4s) and Haploconus entoconus, n. sp. (type - lower jaw with partial dentition).

COPE, E.D., 1882g.
A new form of Taeniodonta.
Amer. Nat. 16:831-832. No illus.

This report is another of a series of short articles in which new taxa were described from the Puerco (Nacimiento) Formation of the San Juan Basin. Hemiganus vultuosus, a new genus and species, was tentatively assigned to the order Taeniodonta. It is not possible to determine exactly what constitutes the type specimen, but upper and lower teeth were described and measured.

COPE, E. D., 1882h.
Some new forms from the Puerco Eocene.
Amer. Nat. 16:833-834. No illus.

Five new species of mammals were named in this article (Mioclaenus protogonoides, type - upper molars; M. opisthacus, type - lower dentition, three individuals listed; M. baldwini, type - lower jaw with dentition; Protogonia plicifera, type - lower jaw with dentition; Dissacus carnifex, type-lower jaw with dentition). Presumably all the above taxa were based on specimens from the Puerco (Nacimiento) Formation of the San Juan Basin.

COPE, E. D., 1883a.
New Mammalia from the Puerco Eocene.
Amer. Nat. 17:191. No illus.

This article represents the summary of a talk given before the American Philosophical Society in which nine new vertebrate taxa from northwestern New Mexico were named. Except for Helagras prisciformis, a snake, all are mammals. These are, Mixodectes pungens, n. gen. et sp., M. crassiusculus, n. sp., Triisodon levisianus, n. sp., Phenacodus calceolatus, n. sp., Mioclaenus meniscus, n. sp., M. bucculentus, n. sp., and M. ferox n. sp. No type specimens were mentioned in connection with these new species.

COPE, E. D., 1883b.
Some new Mammalia of the Puerco Formation.
Amer. Nat. 17:968. No illus.

This article is the summary of a talk given before the Philadelphia Academy. The new taxa named were from northwestern New Mexico. Included forms are Zetodon gracilis, Periptychus coarctatus, and Pantolambda cavirictus. No types were given.

COPE, E. D., 1883c.
First addition to the fauna of the Puerco Eocene.
Amer. Philos. Soc. Proc. 20:545-563. No illus.

Author's Abstract

There are fifty-five species included in my synopsis of the vertebrata of the Puerco epoch. Ten of these are reptilia, the remainder mammalia. In the present paper a number of interesting additions are made. The typical specimens are figured in the fourth volume of the U.S. Geological [Geographical] Survey of the Territories, now in press.

New vertebrata included in this paper are Helagras prisciformis, n. gen. et sp. (type - vertebrae), Triisodon levisianus, n. sp. (type - incomplete dentary with dentition), Mioclaenus ferox, n. sp. (type - incomplete skeleton including partial dentition), M. bucculentus, n. sp. (type - incomplete maxillary with dentition), M. corrugatus, n. sp. (type - maxillary with P^4-M^3 and several postcranial bones), Mixodectes Pungens, n. sp. (type - lower jaws with dentition), M. crassiusculus, n. sp. (type - fragments

COPE, E. D., 1884a.
On new lemuroids from the Puerco Formation.
Amer. Nat. 18:59-62. No illus.

It appears that only one new species was named in this article, Indrodon malaris (type specimen - incomplete skull with dentition). Its characters were given and its relationship with other early forms, some of which are not positively lemuroids, was discussed.

COPE, E. D., 1884b.
Second addition to the knowledge of the Puerco epoch.
Amer. Philos. Soc. Proc. 21:309-324. No Illus.

This is a paper read before the American Philosophical Society. Several new mammalian taxa from the San Juan Basin in New Mexico were named and described. These new forms are Didymictis primus, n. sp. (type - two maxillaries with dentition and an incomplete dentary with M_{2-3}, all from different individuals), Triisodon assurgens, n. sp. (type - lower jaw with P_4-M_3), Mioclaenus cuspidatus, n. sp. (type - ? upper dentition), Chriacus truncatus, n. sp. (type - ? maxilla with dentition), C. simplex, n. sp. (type - maxilla and incomplete dentary with partial dentition), Tricentes crassicollidens, n. gen. et sp. (type - ? partial skull with dentition), T. inaequidens, n. sp. (type - incomplete skull with partial dentition), Indrodon malaris, n. gen. et sp. (type - partial skull with dentition), Anisonchus agapetillus, n. sp. (type - six incomplete dentaries with partial dentition), A. cophater, n. sp. (type - lower jaw with three cheek teeth), Chirox plicatus, n. gen. et sp. (type -P^3, M^{2-3}) and Catopsalis fissidens, n. sp. (type - incomplete lower jaw with dentition).

COPE, E. D., 1885a.
The oldest Tertiary Mammalia.
Amer. Nat. 19:385-386. No illus.

Additional new mammalian taxa from the Early Tertiary of the San Juan Basin were briefly described in this paper. These include Loxolophus adapinus, n. gen. et sp. (type specimen - lower molars), Polymastodon latimolis, n. sp. (type specimen - lower jaw with dentition), Chriacus hyattianus, n. sp. (type specimen - type - two maxillae and an incomplete lower jaw with partial dentitions) and Sarcothraustes coryphaeus, n. sp. (type specimen - incomplete skull with partial dentition).

COPE, E. D., 1885b.
Marsupials from the lower Eocene of New Mexico.
Amer. Nat. 19:493-494. No illus.

Several species of presumed marsupials (actually multituberculates) from the San Juan Basin were briefly discussed in this paper. One of these is new, Polymastodon attenuatus (type specimen - dentary with complete dentition).

COPE, E. D., 1885c.
The relations of the Puerco and Laramie deposits.
Amer. Nat. 19:985-986. No illus.

Cope showed that the Puerco and Laramie deposits are not correlative, but that the former is of later age. The Laramie deposits, as he pointed out, contain abundant dinosaurian material, whereas the Puerco deposits contain none. When the Cretaceous mammalian fauna becomes better known, Cope predicted it will probably agree with the Puerco in its leading features.

COPE, E. D., 1886
The Plagiaulacidae of the Puerco epoch.
Amer. Nat. 20:451. No illus.

Three species representing this family were recovered from the Puerco deposits in New Mexico. These are Ptilodus mediavus, P. trovessartianus and Neoplagiaulax americanus. A fourth species, N. Molestus, was added to this family (type specimen - P_4). Up to that time, Plagiaulacidae was the largest family known.

COPE, E. D., 1887.
Some new taeniodonta of the Puerco.
Amer Nat. 21:469. No illus.

A right mandibluar ramus from the upper beds of the Puerco Formation represents a new species of Psittacotherium. This new species is P. megalodus which exceeds the size of the other two.

COPE, E. D., 1888a.
Synopsis of the vertebrate fauna of the Puerco series.
Amer. Philos. Soc. Trans. 16:298-361. 11 Figures, 2 Plates.

This paper is an early published report on the vertebrates from the San Juan Basin. The recorded fossils come from the Puerco Formation as recognized by Cope. The taxa presented, some of which are new, received discussion at some length. Collecting sites were not recorded. New taxa included a turtle, Chelydra crassa, n. sp. (type specimen - no number given, an incomplete caropace and plastron); Onychodectes tisonensis, n. gen.

et sp. (type specimen - several bones, cranial and postcranial of one individual, including both maxillaries with dentition); Mioclaenus bathygnathus, n. sp. (type specimen - left dentary with partial dentition); M. pentacus, n. sp. (type specimen - dentaries of seven individuals with partial dentitions); M. quadrianus, n. sp. (type specimen - several skull fragments of one individual including partial dentition); M. lydekkerianus, n. sp. (type specimen - inferior molars); M. filholianus, n. sp. (type specimen - dentary with partial dentition); M. floverianus, n. sp. (type specimen - parts of two dentaries with partial dentition); M. zittelianus, n. sp. (type specimen - nearly complete skull and mandible with dentition); M. turgidunculus, n. sp. (type specimen - maxillary with partial dentition); Chriacus priscus, n. sp. (type specimen - incomplete skull with partial dentition); C. schlosserianus, n. sp. (type specimen - both maxillaries and dentaries with partial dentition and isolated postcranial bones); C. ruetimeyeranus, n. sp. (type specimen - incomplete dentary with partial entition); C. stenops, n. sp. (type specimen - four dentaries of three individuals with partial dentitions); C. inversus, n. sp. (type specimen - incomplete dentary with partial dentition); Triisodon biculminatus, n. sp. (type specimen - incomplete dentaries of two individuals with partial dentitions) and Haploconus corniculatus, n. sp. (type specimen - five skulls and one mandible with dentition).

COPE, E. D., 1888b.
Vertebrate fauna of the Puerco series.
Science 11:198. No illus.

This one paragraph article represents the summary of a verbal report. It was stated that the Puerco series represented a time between the Cretaceous and Eocene and, therefore, is not referable to either. At the time of this report, 106 vertebrate species had been described; 12 reptiles, 1 bird and 93 mammals.

COPE, E. D., 1888c.
The vertebrate fauna of the Puerco epoch.
Amer. Nat. 22:161-163. No illus.

This paper serves to review the Puerco fauna in very general terms including some recent findings which necessitated some revision. Concepts were also included on ancestral mammals [therians] and their observed and supposed characters.

DANE, C. H., W. A. COBBAN, AND E. G. KAUFFMAN, 1966.
Stratigraphy and regional relationships for the Juana Lopez Member, Mancos Shale, in the San Juan Basin, New Mexico.
U.S. Geol. Surv. Bull. 1224H:1-15.

A well exposed stratigraphic section near La Ventana, New Mexico was presented as the reference section for the Juana Lopez Member. Ribbed oysters, Inoceramus and the ammonite Prionocyclus, Baculites, Coilopoceras and Scaphites dominate the faunas in the 9 beds of this member. Fossils in the Juana Lopez Member on the east side of the San Juan Basin are distributed in distinct laterally persistant faunal zones.

DANE, C. H., E. G. KAUFFMAN AND W. A. COBBAN, 1968.
Semilla Sandstone, a new member of the Mancos Shale in the southeastern part of San Juan Basin, New Mexico.
U.S. Geol. Surv. Bull. 1254-F:1-21.

The Semilla Sandstone is a sandstone member in the lower part of the Mancos Shale in northwestern Sandoval County, New Mexico. The type section of this member lies within the ammonite zone of Prionocyclus hyatti (Stanton) as defined by Cobban and Reeside. Mollusks and arthropods are abundant. Among the fauna are plicate oysters, Pinna, Cymbophora, Turritella, Trigonarca, Tellina, Cardium, and others. The beds are riddled to within 15 feet of the top of the member at several levels by the burrowing of marine worms and callianassid crabs. A crab carapace was collected.

DANE, C. H., E. R. LANDIS AND W. A. COBBAN, 1971.
The Twowells Sandstone Tongue of the Dakota Sandstone and the Tres Hermanos Sandstone as used by Herrick (1900), Western New Mexico.
U.S. Geol. Surv. Prof. Paper 750B:B17-B22.

The fauna of the Twowells Sandstone Tongue as was given in this paper is Gryphaea newberryi, "Mantelliceras" sp., Metoicoceras defordi Young, Acanthocardia tritis (White), Inoceramus sp., Lopha sp. (Large), Pholadomya sp., Pinna sp. and Cerithiopsis sp.

DELEVORYAS, T., 1959.
Investigations of North American cycadeoids: Monanthesia.
Amer. Jour. Bot. 46:657-666. 23 Figures.

The author discussed the history, anatomy and relationships of Monanthesia with special emphasis on the specimens collected from the Upper Cretaceous of the San Juan Basin of New Mexico. Delevoryas assigned all of these specimens to the species M. magnifica.

DICKINSON, R. G., E. G. LEOPOLD AND R. MARVIN, 1968.
Late Cretaceous uplift and volcanism on the North Flank of the San Juan Mountains, Colorado.
In Cenozoic volcanism in the southern Rocky Mountains: Colo. School Mines Quart. 6:125-148.

This article discusses the Cimarron Ridge Formation which crops out in the Cimarron Ridge are on the north flank of the San Juan Mountains, Colorado. The rocks may correlate with the McDermott Member of the volcanic-derived Animas Formation in the San Juan Basin.

Pollen samples were analyzed from 10 samples spanning the Fruitland Formation, the Kirtland Shale and one sample from Cimarron Ridge Formation. The information from these samples substantiates Anderson's interpretation of the sedimentary environment of the Kirtland as representing a swampy area behind the retreating Lewis Sea. The presence of coals in the Fruitland Formation in the Cimarron Ridge area suggests a similar environment behind a retreating Mancos Sea.

An important change occurs near the top of the Kirtland Shale. A dramatic impoverishment of the flora takes place with the loss of 14 species of angiosperms and fern taxa from the Fruitland Formation and the Kirtland Shale. In their place, abundant saccate conifer pollen of the Pinaceae and Podocarpaceae suddenly appear along with certain new angiosperm groups. The change from what was undoubtedly a basin flora in the Fruitland and lower part of the Kirtland to an impoverished flora of possible upland environment at the top of the Kirtland suggest that an uplift occurred during late Kirtland time.

EVERNDEN, J. F., D. E. SAVAGE, G. H. CURTIS AND G. T. JAMES, 1964.
Potassium-argon dates and the Cenozoic mammalian chronology of North America.
Amer. Jour. Sci. 262:145-198. 1 Figure, 7 Tables.

This important paper provides radiometric dates for the established North American mammal ages. The authors leave little doubt that the defined Land Mammal Ages are time sequential and that the potassium-argon method of dating is sufficiently accurate to distinguish events separated by 0.2×10^6 years at 1.5×10^6 years, and 1×10^6 years at 50×10^6 years. The Puercan and Torrejon Ages, based on Paleocene mammals from the San Juan Basin of New Mexico, were listed in this paper and a number of taxa given which help define them.

FASSETT, J. E., 1973.
The saga of the Ojo Alamo Sandstone; or the rock-stratigrapher and the paleontologist should be friends.
Cretaceous and Tertiary rocks of the southern Colorado Plateau, Four Corners Geol. Soc. Mem.:123-130.

The author gives his version of the history of the Ojo Alamo Sandstone nomenclature and the problems associated with it and its age. The vertebrates have been the basis for the age determinations. Dinosaurs (Cretaceous) are present in the lower portion and Paleocene mammals are present in the top.

FASSETT, J. E. AND J. S. HINDS, 1971.
Geology and fuel resources of the Fruitland Formation and Kirtland Shale of the San Juan Basin, New Mexico and Colorado.
U.S. Geol. Surv. Prof. Paper 676:1-76.

The article gives the depositional history of the Upper Cretaceous and Paleocene formations in the San Juan Basin. The fuel resources, such

as uranium, oil, gas and coal, of the Fruitland Formation and Kirtland Shale, as well as their occurrences, were also discussed. Fassett and Hinds included preliminary analyses of mammalian fossils from the Fruitland Formation by Clemens.

FUSCH-PARKER, J. W., 1977.
Alibi for a Mesa Verde misfit--the La Ventana Formation Cretaceous Delta, New Mexico.
New Mexico Geol. Soc. Guidebook, 29th Field Conf.:199-206.

Based upon trough cross-stratification of sandstones in the La Ventana area, a delta with a general southeast source is postulated. Leaf fossils were found as impressions in sandstones just north of the town of La Ventana and in ironstone concretionary beds among shales and coaly shales in several localities. Large, tubular, brown pipe-and gourd-shaped cavities, which may represent lungfish burrows, occur in the main sandstone members.

GARDNER, H. H., 1910.
The Puerco and Torrejon formations of the Nacimiento Group.
Jour. Geol. 18:702:741.

The subject of the beds of the Nacimiento is of much interest to science because of the character of their vertebrate faunas and their stratigraphic position. This article gives a history of the stratigraphic nomenclature and problems of these formations up to 1910. The author proposed the name Nacimiento Group to encompass these two formations. He listed the fossil vertebrate fauna and stated that unfortunately the Nacimiento had not furnished any fossil leaves. The only indication of a flora being found is in the form of silicified limbs, trunks and stumps of dicots and palm trees.

GAZIN, C. L., 1937.
Hunting for fossils in the Navajo country.
Explor. Fldwk., Smith. Inst. 19-22. 4 Figures.

This article essentially gives an itinery in lay terms of collecting in the San Juan Basin in 1936. Several sites, some discovered by Cope were collected in Paleocene deposits.

GAZIN, C. L., 1968
A new primate from the Torrejon middle Paleocene of the San Juan Basin, New Mexico.
Biol. Soc. Wash. Proc. 81:629-634. 3 Figures.

Modification from Author's Text

Primates were unknown from the Torrejon beds of the Nacimiento Formation until reported from the Angel Peak basin by Wilson (1951, 1956). A new genus and species was described and discussed (Torrejonia wilsoni, type specimen - USNM No. 25255, lower jaw including P_3-M_2).

GILMORE, C. W., 1916.
Contributions to the geology and paleontology of San Juan County, New Mexico.
U.S. Geol. Surv. Prof. Paper 98-Q:297-308. 15 Figures, 7 plates.

Modification of Author's Introduction and Text

This paper attempts to bring together all the known information relating to the extinct vertebrate fauna of the Ojo Alamo and immediately underlying deposits. Prior to this paper, a considerable number of genera and species were described in widely scattered publications. Two new chelonian species were described (Neurankylus baueri, type specimen - USNM No. 8344, carapace and plastron; Baena nodosa, type specimen - USNM No. 8345, nearly complete carapace and plastron).

GILMORE, C. W., 1919.
Reptilian faunas of the Torrejon, Puerco, and underlying upper Cretaceous formations of San Juan County, New Mexico.
U.S. Geol. Surv. Prof. Paper 119:1-68. 33 Figures, 26 plates.

Modification from Author's Introduction

Specimens described in this article were collected at many localities in several zones of the Puerco, Torrejon, Ojo Alamo, Kirtland and Fruitland formations of the San Juan Basin. This collection is especially rich in turtle remains and represents the best single collection of fossil turtles from the southwestern United States. Sixteen new species were described. The recovery of additional though incomplete dinosaur specimens shows taxa previously not reported. Presence of fish and crocodiles was recorded on the basis of incomplete materials.

GILMORE, C.W ., 1921.
Discovery of sauropod dinosaur remains in the Upper Cretaceous of New Mexico.
Science 54:274. No illus.

The discovery of the scapula of a sauropod dinosaur from the Ojo Alamo Formation in the San Juan Basin was announced in this short article. It represents the first evidence of a Late Cretaceous sauropod from North America. The size and configuration of this specimen precludes its being assigned to another dinosaurian group.

GILMORE, C. W., 1922.
A new sauropod dinosaur from the Ojo Alamo formation of New Mexico.
Smithsonian Misc. Coll. 72:1-9. 2 Plates.

In this article the first sauropod dinosaur from Late Cretaceous deposits in North American was named and described. It was recovered

from Barrel Spring Arroyo, one mile south of Ojo Alamo. This new taxon was named Alamosaurus sanjuanensis (type specimen - USNM No. 10486, a nearly complete scapula). In addition to the type, a nearly complete ischium found about 200 feet distant from the scapula at the same stratigraphic level was also referred to this species.

GILMORE, C. W., 1935.
On the Reptilia of the Kirtland formation of New Mexico, with descriptions of new species of fossil turtles.
U.S. Nat. Mus. Proc. 83:159-188. 15 Figs., 5 Tables, 6 Plates.

The reptilian fossils described in this paper included several genera of dinosaurs and turtles collected from the San Juan Basin. One fish tooth, of the family Squatinidae was also recorded. Four new chelonian species were described (Baena ornata, type specimen - USNM No. 13229, carapace and plastron; Boremys grandis, type specimen - USNM No. 12979, carapace and plastron; Thescelus hemispherica, type specimen - USNM No. 12818, incomplete carapace and plastron; Aspideretes ovatus, type specimen - USNM No. 12986, incomplete carapace and plastron fragments).

GRANGER, W., 1914.
On the names of lower Eocene faunal horizons of Wyoming and New Mexico.
Amer. Mus. Nat. Hist. Bull. 33:201-207. No illus.

This article contains a brief statement about supposed Wasatch bed equivalents in northwestern New Mexico. The absence of Eohippus was considered noteworthy. The genus Meniscotherium was the only taxon given for New Mexico.

GRANGER, W., 1915.
A revision of the lower Eocene Wasatch and Wind River faunas. Part III--Order condylarthra. Families Phenacodontidae and Meniscotheriidae.
Amer. Mus. Nat. Hist. Bull. 34:329-361. Illus.

Systmatic revision of the phenacodontid and meniscotheriid condylarths, including many specimens from the San Jose formation is made in this report. It is well illustrated.

GRANGER, W., 1917.
Notes on Paleocene and lower Eocene mammal horizons of northern New Mexico and southern Colorado.
Amer. Mus. Nat. Hist. Bull. 37:821-830. 1 Figure, 2 Plates.

This paper gives brief results of field work in the San Juan Basin. Two of the three areas collected are in New Mexico; one in the Angel Peak area, the other between Aztec and Cedar Hill along the Animas River. A number of mammalian taxa, mostly at the generic level, are listed but not discussed. However, approximate stratigraphic levels are recorded for them.

HAY, O. P., 1911.
Descriptions of eight new species of fossil turtles from west of the one-hundredth meridian.
Proc. U.S. Nat. Mus. 38(1747):307-326.

The author described the new species Compsemys parva, C. vafer, Basilemys nobilis, Adocus vigoratus and Hoplochelys bicarinata from near Ojo Alamo, San Juan County, New Mexico.

HENDERSON, J., 1935.
Fossil non-marine mollusca of North America.
Geol. Soc. Amer. Spec. Paper 3:1-313.

Over 700 species and subspecies of fossil non-marine mollusca (bivalves and gastropods) were included in this systematic list of species. Also included were their stratigraphic and geographic occurrences. A systematic annotated catalogue was included for each species or subspecies. This represents a comprehensive systematic review and index of the non-marine mollusc fossils known from North America up to 1935.

HOOK, S. C. AND W. A. COBBAN, 1977.
Pycnodonte newberry (Stanton); common guide fossil in Upper Cretaceous New Mexico.
New Mexico Bur. Mines Min. Res. Ann. Rept. 1976-77: 48-54. 5 Figures.

The Late Cretaceous oyster Pycnodonte newberryi (referred to in the older literature as Gryphaea newberryi) fits the criteria as a guide or index fossil for the Late Cenomanian and early Turonian in New Mexico and adjacent Four Corners States.

Pycnodonte newberryi's stratigraphic occurrence and characteristic features were described in modest detail.

HOOK, S. C. AND W. A. COBBAN, 1978.
Prinonocyclus novimexicanus (Marcou)--common Upper Cretaceous guide fossil in New Mexico.
New Mexico Bur. Mines Min. Res. Ann. Rept. 1977-1978:35-42.

This is the second paper of a series on invertebrate fossils of Cretaceous age in New Mexico. It includes a brief history and detailed description of the late Turonian ammonite Prionocyclus novimexicanus (Marcou) and a brief description of the commonly associated ammonite Scaphites whitefieldi Cobban.

KAY, R. F., AND M. CARTMILL, 1974.
Skull of Palaechthon nacimienti.
Nature 252:37-38. 1 Figure.

The specimen upon which this article is based comes from Kutz Canyon in the San Juan Basin of New Mexico. It was previously described by Wilson and Szalay (1972). This present article briefly discussed the affinities of Palaechthon nacimienti, and then more fully treats its morphology.

KAY, R. F., AND M. CARTMILL, 1977.
Cranial morphology and adaptations of Palaechthon nacimienti and other Paromomyidae (Plesiadapoidea (?) Primates), with a description of a new genus and species.
Jour. Human Evol. 6:19-53.

This article represents an expanded version of Kay and Cartmill (1974) with a detailed functional analysis of the skull of Palaechthon nacimienti.

KNOWLTON, F. H., 1916.
Contributions to the geology and paleontology of San Juan County, New Mexico, part 4, flora of the Fruitland and Kirtland Formations.
U.S. Geol. Surv. Prof. Paper 98:327-344.

The fossil plant materials upon which Knowlton's report was based came from 20 different localities. Fifteen were from the Fruitland Formation, three from the Kirtland Shale and two from the Ojo Alamo Sandstone. The majority of his materials were collected from lower or the coal-bearing portion of the section. Most of the fossil plants were preserved on a red baked shale, indicating proximity to coal.

KNOWLTON, F. H., 1924.
Flora of the Animas Formation.
U.S. Geol. Surv. Prof. Paper 134:71-117.

This report is based upon fossil plant remains collected in the northeast portion of the San Juan Basin in Colorado. Knowlton described 59 species of fossil plants from this formation. Three of these are ferns. One is a palm and the remainder are assigned to dicots.

KUES, B. S., J. W. FROEHLICH, J. A. SCHIEBOUT AND S. G. LUCAS, 1977.
Paleontological survey, resource assessment, and mitigation plan for the Bisti-Star Lake Area, northwestern New Mexico.
U.S. Bur. Land Manage., Albuquerque Office, Oct. 31, 1977:1-399.
12 Figures, 9 Tables, 6 Appendices.

Modification of Author's Abstract

A comprehensive paleontological survey of the San Juan Basin was made from March to October, 1977. It provided data relevant to fossil sites and known occurrences of recoverable coal. Most of the area contains exposures of Cretaceous and Early Tertiary rocks representing a spectrum from fully marine to fully terrestrial environmental conditions. Included formations yield an almost unparalleled record of one of the most important episodes in the history of life -- the abrupt change from terrestrial communities dominated by dinosaurs to those dominated by mammals.

Over 1100 fossil-bearing sites were discovered in the present survey, most of them in areas likely to be disturbed for coal recovery. Many of the fossils from these sites have been identified and appear in the report on faunal lists.

Recommendations were made to establish six areas in the study area as paleontological reserves. These preserved areas should be completely protected for future paleontological research.

KUES, B. S., R. V. INGERSOLL AND S. G. LUCAS, 1978.
Paleontological survey, resource assessment, and mitigation plan for the southern half of the Rio Grande resource area, north-central New Mexico.
U.S. Bur. Land Manage., Albuquerque Office, Nov. 25, 1978
1-298 (unpubl.). 9 Figures, 10 Tables, 5 Appendices.

This report includes significant data as related in the title. It also provides floral and faunal lists of recovered fossil specimens as well as their areas of discovery. Additionally, relative

importances were given to different types of fossils and different types of occurrences. The usefulness of fossils has also been given consideration.

LAMB, G. M., 1964.
Microfaunal changes within lower Mancos Shale, San Juan Basin, New Mexico and Colorado.
Geol. Soc. Amer. Spec. Paper 82:117. No illus.

Modification of Author's Abstract

The occurrence of forams belonging to six distinct zones in the lower Mancos Shale are related to calcium carbonate content of the shales. Greatest concentrations of calcium carbonate and planktonic foraminifera are found in the transgressive phases. Low calcium carbonate content, and a marked decrease in foram abundance, mainly arenaceous, is typical of regressive phases.

LAMB, G. M., 1968.
Stratigraphy of the lower Mancos Shale in the San Juan Basin.
Geol. Soc. Amer. Bull. 79:827-854. 5 Figures.

Modification of Author's Abstract

The stratigraphy of the lower Mancos Shale in the San Juan Basin was discussed and correlated. Foraminifera within the lower Mancos were identified, and the paleogeography and paleoecology of the sediment was interpreted. The identification and occurrence of the foraminifera at two sections was presented in some detail.

LAMB, G. M., 1969.
Two new species of foraminifera from the Lower Mancos Shale (Upper Cretaceous) of the San Juan Basin, New Mexico.
Cushman Found. for Foraminiferal Res. 20:143-144. 1 Plate.

Modification of Author's Abstract

Two new species of foraminifera are described from the lower Mancos Shale in Red Wash, approximately 1/4 mile north of Highway 504 in Sections 11 and 12, T30N, R20W, San Juan Co., New Mexico.

LANDIS, E. R., C. H. DANE AND W. A. COBBAN, 1973.
The Dakota Sandstone and Mancos Shale in the Laguna-Acoma-Grants area, New Mexico.
Four Corners Geol. Soc. Mem.:28-36.

The intertongued Dakota Sandstone and Mancos Shale formations were divided into formal and informal rock units in this report. In their measured sections, Gryphea newberryi and Sciponoceras gracile occur in the Twowells Sandstone Tongue. Ophiomorpha sp., Exogyra sp. and Acanthoceras amphibolum are found in the Paguate Sandstone Tongue. Exogyra sp. and Plicatula arenaria are present in the Cubero Sandstone Tongue and Oak Canyon Member of the Dakota Sandstone.

LEE, W. T., 1912.
Stratigraphy of the coal fields of northern central New Mexico.
Geol. Soc. Amer. Bull. 23:571-686.

This article represents a comprehensive study of the coal containing formations of northern and central New Mexico and southwestern Colorado up to 1912. Lee listed fossil faunas and floras in attempting to determine the stratigraphic positions of these formations.

LEE, W. T., 1917.
Geology of the Raton Mesa and other regions in Colorado and New Mexico.
U.S. Geol. Surv. Prof. Paper 101:9-221.

This article presents a comprehensive discussion of the stratigraphy of the Raton Basin and adjacent areas, including the San Juan Basin. Faunal and floral lists as well as correlations of some units were included.

LINDSAY, E. H., L. L. JACOBS, AND R. F. BUTLER, 1978.
Biostratigraphy and magnetostratigraphy of Paleocene terrestrial deposits, San Juan Basin, New Mexico.
Geology 6:425-429. 3 Figures.

Authors' Abstract

Biostratigraphy in combination with magnetostratigraphy yields a stratigraphic-chronologic foundation in which biological and environmental changes can be correlated with an independent time frame. This combination promises greater resolution of chronostratigraphic units than those based on faunal change and superposition. The occurrences of early and middle Paleocene land mammals in the San Juan Basin are bracketed relative to the magnetic polarity time scale: mammals of Puercan (early Paleocene) age occur in rocks deposited during magnetic anomaly 28, and mammals of Torrejonian (middle Paleocene) age occur in rocks deposited during magnetic anomaly 26 and during the reversed polarity interval preceding anomaly 26.

LOEW, O., 1874.
A new fossil resin--"Wheelerite."
Amer. Jour. Sci., 3rd Ser. 7:571-572.

Loew described resin found in "Cretaceous lignite beds" near Nacimiento.

LUCAS, S. G., 1977.
Vertebrate paleontology of the San Jose Formation, east-central San Juan Basin, New Mexico.
New Mexico Geol. Soc. Guidebook, 28th Field Conf.: 221-224.

Author's Conclusion

This paper has outlined and, in some cases, offered tentative solutions for several of the problems facing vertebrate paleontologists in the San Jose Formation. Many of these problems would not have arisen if previous collectors had carefully recorded stratigraphic and geographic provenance and also thoroughly studied and reported their collections. Unfortunately such ideals are almost never met in the study of paleontology.

The road is now open for thorough restudy and revision of former collections. In addition, futher collecting, using new methods and a rigorous stratigraphic framework, is necessary. The method of screenwashing for microvertebrate fossils (McKenna, 1965) should be especially productive of new information. With the solution of the problems outlined here and the influx of new information, paleontologists will finally gain a relatively clear and unbiased picture of the vertebrates existing during Wasatchian time in the San Juan Basin of New Mexico.

MACFADDEN, B. J., 1977.
Magnetic polarity stratigraphy and mammalian biochronology of the Chamita Formation stratotype (Mio-Pliocene) of north-central New Mexico.
Doctoral, 1976, Columbia Univ., New York, NY.
(Diss. Abstr. Int. 37:4942B-4943B).

Author's Abstract

The Chamita Formation stratotype (uppermost Santa Fe Group) consists of 50 m of poorly indurated fluviatile clayey silts, silts, sands, and

gravels. Two units termed "lower tuffaceous zone" and "upper tuffaceous zone", which extend from 120 m to 180 m and 320 m to 360 m, respectively, are rich in air-fall and reworked volcaniclastic sediments. A minimum of 3 samples were collected from the finer-grained sediments for each of 135 sites spaced at a maximum stratigraphic interval of 7 m throughout the stratotype.

Based principally on 111 statistically significant sites, the stratotype consists of 12 magnetic polarity zones that are termed "N1-R6." Two previously published fission-track dates, one each from the lower upper tuffaceous zones, and fossil mammals, provide the independent control for the correlation of this magnetic polarity zonation to the standard magnetic polarity time scale. The mammalian assemblage from the stratotype consists of at least 19 taxa mostly concentrated at 325 m above the base. This fauna is generally similar to other late Hemphillian (late Miocene - early Pliocene) mammalian assemblages, e.g., the Coffee Ranch Local Fauna from the Hemphillian stratotype.

Magnetic polarity zones N1-N3, which extend from the base of the stratotype to 285 m, are predominantly of normal polarity; these zones represent medial to late Epoch 5 time.

MACFADDEN, B. J., AND K. MANLEY, 1976.
Magnetic stratigraphy, tephrochronology and mammalian biostratigraphy of the Type Chamita Formation, north-central New Mexico.
Geol. Soc. Amer. Abstr. Programs 8:605. No illus.

Authors' Abstract

The type Chamita Formation of Galusha and Blick (upper Santa Fe Group) of north-central New Mexico is about 500 m thick and consists of poorly indurated clayey silts, silts, sands, and gravels. Two zones of

tephra deposits and reworked volcaniclastic sediments, called the lower and upper tuffaceous zones, are from 120 to 170 m and 320 to 360 m above the base of the formation. Two fission-track dates and characteristic late Hemphillian (Wood and others) mammalian fossils permit correlation of the magnetic stratigraphy of the Chamita with the established geomagnetic-polarity time-scale.

The type Chamita Formation contains six magnetozones that represent middle Epoch 5 to early Gilbert time. Rocks from 0 to 320 m represent middle to late Epoch 5, which is predominantly normal polarity but contains its characteristic reversed Event A for rocks at 112 to 151 m. A zircon fission-track age of 5.2±1.0 m.y. was determined for a pumice layer near the top of the lower tuffaceous zone.

Early Gilbert time, represented by rocks from 320 to 500 m, is reversed polarity except for normal Even C-2 for rocks fom 375 to 430 m. A prolific fossil horizon, which includes the San Juan and Rak Camel quarries, occurs near the base of the upper tuffaceous zone. A zircon fission-track age of 5.6±0.9 m.y. was determined for a pumice layer near the top of the upper tuffaceous zone.

MANNHARD, G. W., 1976.
Stratigraphy, sedimentology, and paleoenvironments of the La Ventana Tongue (Cliff House Sandstone) and adjacent formation of the Mesaverde Group (Upper Cretaceous), southeastern San Juan Basin, New Mexico. Doctoral, 1976, University of New Mexico. Albuquerque, New Mexico. (Diss. Abstr. Int. 38:558B.) No illus.

Author's Abstract.

Detailed outcrop studies were conducted of the La Ventana Tongue and intertonguing units of the Menefee Formation and Lewis Shale in the southeastern San Juan Basin. Seven stratigraphic sections were measured

along an outcrop belt which trends nearly parallel with depositional dip. Extensive data collected on lithology, sedimentary structures, stratigraphic relations, and fossils serve as a basis for interpreting depositional environments and formulating a depositional model.

The Menefee Formation consists of interbedded and repetitive sequences of: 1) fresh water claystones and brown humic shales deposited in well to poorly drained swamp environments; 2) thin tabular splay and levee sandstones and siltstones; and 3) lenticular meander belt and distributary channel sandstones.

Five facies have been recognized in the La Ventana Tongue: 1) fining upward destructional (transgressive) delta front sheet sandstones deposited following abandonment and subsidence of specific parts of the delta system; 2) thin bedded tabular sandstones deposited in the offshore area during storms; 3) thick coarsening upward progradational delta front sheet sandstones deposited in areas of relatively high sediment input: 4) tabular cross-stratified sandstones with shale interbeds, interpreted as channel mouth bar deposits, and 5) lenticular tidal inlet channel sandstones.

Two faunal assemblages have been recognized in La Ventana delta front sandstones: A) diverse mixed assemblage of bivalves and gastropods, secondarily concentrated by wave action in the shoreface zone; and B) non-diverse unfragmented assemblage of Inoceramus in shoreface sandstones, deposited and buried rapidly under storm conditions. The prodelta Lewis Shale contains an assemblage of bivalves, gastropods, and ammonites adapted to the muddy substrate of the middle shelf.

Petrographic studies indicate that delta front sandstones are mainly subarkoses and quartzarenites, whereas channel sandstones are dominantly lithic arkoses and arkoses. Differences are explained by greater abrasion in high energy foreshore and shoreface environments.

Sandstone framework composition and clay mineralogy of mudrocks indicate a varied provenance including: 1) mature sandstones, illitic shales, dolomites, and cherty carbonates; 2) granitic plutonics, felsic volcanics, and volcanic ash; and 3) low rank metamorphics of phyllite and quartz-mica schist.

MARSH, O. C., 1894.
Description of Tertiary artiodactyls.
Amer. Jour. Sci. 48:259-274.

This article consists of descriptions of Eohyus distans (= Phenaceda primaevus) and Eohyus robustus (= Periptychu carinidens) from the San Juan Basin.

MATEER, N. J., 1976.
New topotypes of Alamosaurus sanjuanensis Gilmore (Reptilia: Sauropoda).
Geol. Inst. Univ. Uppsala N.S. 6:93-95. 2 Figures.

Modification of Author's Conclusion

The reported materials, consisting of an ilium, sacrum and two caudal vertebrae were collected by Charles Sternberg in 1922 from Barrel Spring, Ojo Alamo. These bones belong to a large sauropod of rather late geological occurrence. Because these specimens are fragmentary and not particularly well preserved, a detailed comparative study was not viable. A similar description and the fact that these specimens were collected from the same locality as Gilmore's type specimen, suggest that they belong to the species Alamosaurus sanjuanensis, thus making them topotypes.

MATTHEW, W. D., 1897.
A revision of the Puerco fauna.
Amer. Mus. Nat. Hist. Bull. 9-259-323. 20 Figures, 2 Tables.

An attempt to analyze the Paleocene mammalian fauna, from the previously recognized Puerco and Torrejon formations, was made in

this fairly substantial paper. It reviews the work done by Cope in the San Juan Basin. Known taxa were listed and papers containing their descriptions were cited.

MATTHEW, W. D., 1913.
A zalambdodont insectivore from the basal Eocene.
Amer. Mus. Nat. Hist. Bull. 32:307-314. 6 Figures, 2 Plates.

A new genus and species of zalambdodont insectivore is described from the Paleocene (not Eocene) Nacimiento Formation of the San Juan Basin, New Mexico. The new taxon is Palaeoryctes puercensis (type specimen - AMNH No. 15923, skull and jaws with partial dentition). It was compared with several related forms, both extinct and living.

MATTHEW, W. D., 1914.
Evidence of the Paleocene vertebrate fauna on the Cretaceous-Tertiary problem.
Geol. Soc. Amer. Bull. 25:381-402. 2 Figures.

Paleocene vertebrates from various localities in North America were listed, discussed and compared with each other and known European faunas. The most typical and best known fauna reportedly comes from the Puerco and Torrejon formations of the San Juan Basin, New Mexico.

MATTHEW, W. D., 1915a.
A revision of the lower Eocene Wasatch and Wind River faunas. Part I--Order Ferae (Carnivora). Suborder Creodonta.
Amer. Mus. Nat. Hist. Bull. 34:4-103.

This is a systematic revision of early Eocene creodonts of North America, including many specimens from the San Jose Formation.

MATTHEW, W. D., 1915b.
A revision of the lower Eocene Wasatch and Wind River faunas. Part II--order Condylarthra. Family Hyopsodontidae.
Amer. Mus. Nat. Hist. Bull. 34:311-328.

This article presents a systematic revision of selected insectivores (sensu lato), rodents and palaeanodonts from the North American early Eocene, including some specimens from the San Jose Formation.

MATTHEW, W. D., 1937.
Paleocene faunas of the San Juan Basin, New Mexico.
Amer. Phil. Soc. Trans. 30:1-374. 85 Figures, 65 Plates.

This monograph is a classic paper on Paleocene vertebrates, mostly mammals, from the San Juan Basin. Known Cretaceous vertebrates were also listed and discussed. Relationships of the Paleocene vertebrates and their possible correlations were discussed. Seven new vertebrate species, all mammalian, were described (?Protogonodon kimbetovius, type specimen -- AMNH No. 16397, lower jaws with DP_4-M_2; Ectoconus majusculus, type specimen - AMNH No. 16500, skull and nearly complete skeleton; ?Ellipsodon aequidens, type specimen - AMNH No. 823, upper and lower jaw with P^4-M^3; Neoclaenodon procyonoides, type specimen - AMNH No. 16554, upper and lower jaws with partial dentition; Ellipsodon priscus, type specimen - AMNH No. 16403, lower jaws with partial dentition;; Pentacodon occultus, type specimen - AMNH No. 16592, lower jaw with P_4-M_3).

MATTHEW, W. D. AND W. GRANGER, 1921.
New genera of Paleocene mammals.
Amer. Mus. Novitates 13:1-7. No illus.

Only descriptions and brief discussions were included in this paper on Paleocene mammals from Colorado and the San Juan Basin of New Mexico. Taxa from the latter locale included Eucosmodon americanus, n. gen. (type - Neoplagiaulax americanus Cope); Thylacodon pusillus, n. gen. et sp. (type specimen - AMNH No. 16414, lower jaw fragment with M_{2-3}); Acmeodon secans, n. gen. et sp. (type

specimen -- AMNH No. 16599, lower jaw fragment with P_2-M_2); Eoconodon, n. gen. (type - Sarcothraustes coryphaeus Cope); and Mixoclaenus encinensis, n. gen. et sp. (type specimen -- AMNH No. 16601, upper and lower jaws with partial dentition).

MOOK, C. C., 1918.
The habitat of the Sauropod dinosaurs.
Jour. Geol. 26:459-470.

The report summarizes information about sauropods up to the time it was written. The author discussed in detail the environment in which these large animals lived. His main concern was the Morrison Formation as it occurs in Wyoming, Utah, Colorado and northwestern New Mexico.

MOOK, C. C., 1930.
A new species of crocodilian from the Torrejon Beds.
Amer. Mus. Novitates 447:1-11. 7 Figures.

Modification of Author's Introduction

In the American Museum collections of fossil reptiles are the remains of a crocodilian from the Torrejon Beds at Torrejon Arroyo, New Mexico. This represents a new species, Leidyosuchus multidentatus (type specimen - AMNH No. 5179), which is based on a lower jaw, skull fragments, isolated teeth and several postcranial bones, presumably from one individual. No other crocodilian fossils have been previously recorded from the Torrejon Beds. Further study may show that this specimen more properly belongs to a new genus. A description and comparison of this new species were given.

MOOK, C. C., 1942.
A new fossil crocodilian from the Paleocene of New Mexico.
Amer. Mus. Novitates 1189:1-4. 2 Figures

A new genus and species of crocodilian was described from Kimbetoh Wash in the Torrejon Formation of the San Juan Basin. The newly described taxon

is Navajosuchus novomexicanus (type specimen -- AMNH No. 5186, incomplete skull).

NEWBERRY, J. S., 1874.
On the lignite flora of the far west.
New York Lyceum Nat. Hist. Proc., 2nd. Ser.:78-79.

The author discussed the geologic age of the coal beds of northwestern New Mexico and mentioned marine invertebrates above the coal.

NEW MEXICO PALEONTOLOGY TASK FORCE, 1978.
New Mexico's paleontological resources.
New Mexico Paleontological Task Force Education, Finance and Cultural Affairs Dept. 1-78 (unpubl.). 8 Appendices.

Modification of Author's Abstract

New Mexico contains extensive fossil deposits of national and international importance. In addition to their scientific value, the fossils have great potential for educational purposes. Presently some of these fossils are being lost to varying activities (e.g., out-of-state collecting, industry, erosion). Lack of proper facilities and professional personnel as well as a state agency capable of monitoring and coordinating paleontological activities has been detrimental to New Mexico. A recommendation was made to preserve the state's paleontological resources by a comprehensive program.

NORTHROP, S. A., 1962.
New Mexico's fossil record.
New Mexico Quarterly 32:5-74 (supplement). 2 Figures.

From Author's Introduction

This is a story about fossils in New Mexico and their importance. It tells what fossils are and where they occur, how old they are, who found them and who studied them, how they were named, described, and illustrated, and especially what they reveal of the succession of plant and animal life in this state.

Few states can boast of a more complete representation of the geologic column than New Mexico. Every period of the geologic time table is represented somewhere in the state by rocks containing fossils. During the past century the rocks of New Mexico have yielded a considerable array of fossils - more than 3,300 species of plants, invertebrates, and vertebrates. More than 100 new genera and approximately 700 new species have been founded on New Mexico type specimens. The eminent paleontologist George G. Simpson (1948) wrote, "Many of these formations [in the San Juan Basin] are richly fossiliferous and the basin as a whole is one of the most interesting geological regions in the world and contains numerous thrilling chapters of the history of the earth and of life."

OSBORN, H. F., 1898.
A complete skeleton of Coryphodon radians; notes upon the locomotion of this animal.
Amer. Mus. Nat. Hist. Bull. 10:81-92.

Osborn briefly mentions Wortman's 1896 expedition to the San Juan Basin and some of the results of that work.

OSBORN, H. F., 1923.
A new genus and species of Ceratopsia from New Mexico, Pentaceratops Sternbergii.
Amer. Mus. Novitates 93:1-3.

At a locality nine miles northeast of Tsaya, New Mexico, in the Fruitland Formation, a fine skull and parts of a skeleton were collected by Charles H. Sternberg. The specimen represents a ceratopsian with one nasal horn in the median line, two horns above the orbits, and two lateral horns projecting downwards and backwards below the orbits. Hence, the generic name Pentaceratops.

OSBORN, H. F. AND C. EARLE, 1895.
Fossil mammals of the Puerco beds.
Amer. Mus. Nat. Hist. Bull. 7:1-70.

The authors considered the coal beds below the Puerco to be Laramie and the Puerco to contain several Laramie reptiles.

OSTROM, J. H., 1961.
A new species of hadrosaurian dinosaur from the Cretaceous of New Mexico.
Jour. Paleont. 35:575-577. 1 Figure.

The new hadrosaurian species reported in this article is Parasaurolophus cyrtocristatus (type specimen - CNHM No. P27393, partial skeleton with cranial material including a complete cranial crest) from the Fruitland Formation, McKinley County, New Mexico. It is the first known crested hadrosaur from the formation.

OSTRON, J. H., 1963.
Parasaurolophus crytocristatus, a crested hadrosaurian dinosaur from New Mexico.
Fieldiana 14:143-168. 21 Figures.

This article essentially represents an elaboration of the author's 1961 report in which this species was first named and described.

OSTROM, J. H., 1964.
A reconsideration of the paleoecology of hadrosaurian dinosaurs.
Amer. Jour. Sci. 262:975-997.

Evidence was reviewed in this article as to the environments in which these dinosaurs lived. The traditional concept of their eating habit was given. Ostrom proposed that they were primarily terrestrial in their habits rather than aquatic as popularly believed. He mentioned those collected from the San Juan Basin and the type of plants they may have eaten as they survived in this environment.

O'SULLIVAN, R. B., C. A. REPENNING, E. C. BEAUMONT AND H. G. PAGE, 1972.
Stratigraphy of the Cretaceous rocks and the Tertiary Ojo Alamo Sandstone, Navajo and Hopi Indian reservations, Arizona, New Mexico and Utah.
U.S. Geol. Surv. Prof. Paper 521-E:1-65. Illus.

This report constitutes a basic study of the stratigraphy of the Cretaceous and Early Tertiary strata of these Indian lands which encompass much of the western San Juan Basin. Fossils encountered during their investigation are discussed. These were listed in association with the age assignments and correlations of the various formations involved.

OWEN, D. E., 1973.
Depositional history of the Dakota Sandstone, San Juan Basin area, New Mexico.
Four Corners Geol. Soc. Men.:37-51.

The Dakota Sandstone in the San Juan Basin area includes strata which were deposited under diverse marine and non-marine conditions. The paper shows the primary structures, bioturbation, fossils and lithologies of this formation. From this data, the author formulated a model to explain changes in environments in time and space. He stated that fossils in the Dakota Sandstone are not really as rare as usually assumed. Many beds, especially in the upper part of the Dakota and in the southeastern portion of the San Juan Basin, contain oysters in great numbers, other bivalves, gastropods, a few ammonites, and plants. In addition, several types of trace fossils are common in many beds of the formation.

POWELL, J. S., 1973.
Paleontology and sedimentation of the Kimbeto Member of the Ojo Alamo Sandstone.
Cretaceous and Tertiary Rocks of the southern Colorado Plateau.
Four Corners Geol. Soc. Mem.:111-122.

A brief history of the stratigraphy of the Ojo Alamo Sandstone was given, and the author proposed that the Ojo Alamo Sandstone as defined by Bauer (1916, p. 276) be reinstated. He further proposed the name Naashoibito Member conglomerate be named the Kimbeto Member of the Ojo Alamo Sandstone.

A history of the paleontology was also discussed. The taxa of the Hunter's Wash Local Fauna (near Bisti) and the Alamo Local Fauna (near Ojo Alamo Spring) were included. However, these faunas are partly from the Kirtland Shale and the Fruitland Formation, as well as, from the Ojo Alamo Sandstone.

REYNOLDS, T. E., 1931.
New insectivores from the lower Paleocene.
Geol. Soc. Amer. Bull. 42:368. No illus.

Author's Abstract

During the past field season two skull fragments with associated lower jaws were collected from the Puerco, or lower member of the Paleocene, San Juan basin of New Mexico. The molars are of a very primitive type approaching a zalambdodont pattern. This is the first insectivore material from the lower Puerco. A second skull with associated lower jaw was collected but a short distance from the first, but with teeth of a more advanced type.

It is thought that these specimens add much to the interesting history of the ancient group and add new evidence as to the nature of the fauna of Paleocene times.

RATKEVICH, R. P., 1976.
Dinosaurs of the Southwest.
Univ. New Mexico Press, Albuquerque, NM 1-115.

This is a generalized book on dinosaurs. It covers the earliest dinosaurs to those that became extinct in the Cretaceous. The author mentioned several famous localities for dinosaurs in New Mexico, but nothing specific.

REESIDE, J. B., JR., 1924.
Upper Cretaceous and Tertiary formations of the western part of the San Juan Basin Colorado and New Mexico.
U.S. Geol. Surv. Prof. Paper 134:1-70.

This paper presents a more or less detailed description of the formations, geologic map and columnar sections of the Upper Cretaceous and Tertiary formations of the San Juan Basin of Colorado and New Mexico. Reeside mentioned the flora and fauna of these formations.

REYNOLDS, T. E., 1936.
Two new insectivores from the Lower Paleocene of New Mexico.
Jour. Paleont. 10:202-209. 2 Figures, 1 Plate.

One of the new forms (Puercolestes simpsoni n. gen. et sp., type specimen - St. Louis Univ. No. 101, palate with incomplete dentition) was classified as an insectivore, but the other was actually listed as a creodont (Escatepos campi, n. gen. et sp., type specimen - St. Louis Univ. no. 118, palate with incomplete dentition). Both reportedly were obtained from the Puerco beds in the Arroyo Eduardo of the San Juan Basin, New Mexico.

RIGBY, J.K., JR., AND S. G. LUCAS, 1977.
Fossil mammals from the Ojo Alamo Sandstone.
New Mexico Geol. Soc. Guidebook Suppl., 28th Field Conf.
55-56. 1 Figure.

Authors' Summary

Recently recovered fossil mammal material documents the basal Tertiary age of the upper part of the Kimbeto member of the Ojo Alamo Sandstone along Betonnie Tsosie Wash. If the sandstone body is equivalent to a similar body in the Barrel Springs Arroyo section of Butler, Lindsay and Jacobs (1977) then the Cretaceous/Tertiary contact can be stated with some confidence to be located within the Kimbeto member. This data suggests the placement of the boundary substantially below paleomagnetic anomaly 30 of Butler, Lindsay and Jacobs and serves to reduce the ambiguity of the contact in the San Juan Basin.

RUSSELL, L. S., 1930.
Upper Cretaceous dinosaur faunas of North America.
Amer. Philos. Soc. Proc. 69(4):133-159.

This is a report on dinosaur-bearing formations of North American Upper Cretaceous which were divided into four stages. Russell placed the faunas of the Fruitland, Kirtland and Ojo Alamo in the third or Fox Hills stage. He listed the dinosaurs described from these formations and considered them to represent one fauna. No specific localities were given.

SIEMERS, C. T. AND N. R. KING, 1974.
Macroinvertebrate paleoecology of a transgressive marine sandstone. Cliff House Sandstone (Upper Cretaceous) Chaco Canyon, northwestern New Mexico.
New Mexico Geol. Soc. Guidebook, 25th Field Conf.: 267-277.

The authors listed the invertebrates which occur in the Cliff House Sandstone in Chaco Canyon and showed that they comprise four different assemblages. Although there are certain exceptions, they indicate that their living relatives live mostly in shallow marine environments. The authors concluded that the Cliff House Sandstone represents a near stand still of the strandline.

SIMPSON, G. G., 1936a.
Additions to the Puerco fauna, lower Paleocene.
Amer. Mus. Novitates 849:1-11. 6 Figures.

The descriptions and comments published in this article were originally prepared as an appendix to "Paleocene Faunas of the San Juan Basin, New Mexico," by W. D. Matthew (1937). Several new genera and species of mammals from the Puerco Formation, Bitonitsoseh and Barrel Spring Arroyos, were briefly diagnosed and discussed in this article (Kimbetohia campi, n. gen. et sp., type specimen - UCMP No. 31305, skull fragment with M_1-M_3; Chriacus antiquus, n. sp., type specimen - AMNH No. 27713, right and left lower jaws

with partial dentition; Tiznatzinia vanderhoofi, n. sp., type specimen - UCMP No. 31264, partial lower left jaw with P_4-M_2; Plagioptychus matthewi, n. gen. et sp., type specimen - AMNH No. 27712, lower right jaw with P_2-M_2).

SIMPSON, G. G., 1936b
Census of Paleocene mammals.
Amer. Mus. Novitates 848:1-14. No illus.

In the course of a general review of the Paleocene mammalian faunas, Simpson compiled a list of all the definitely identified genera found in the Paleocene formations of the world. The information was widely scattered in over a hundred papers by twenty-five or thirty authors. Publication of this generic list facilitated, not only the task of identifying Paleocene mammals, but efforts to learn something of these important faunas. The San Juan Basin is one of the few North American localities yielding Paleocene mammals.

SIMPSON, G. G., 1941.
Mounted skeleton and restoration of an early Paleocene mammal.
Amer. Mus. Novitates 6(1155):1-7.

This is a discussion of a skeleton of Ectoconus majusculus collected from the Puerco (Nacimiento?) Formation of Kimbeto Arroyo, San Juan Basin, New Mexico.

SIMPSON, G. G., 1948a.
A fossil collecting campaign in New Mexico.
Science 107:207-212.

This article is a popular account of vertebrate collecting in the summer of 1947. Triassic localities were described in the Ghost Ranch area. Simpson mentioned a discovery site for the Eocene mammal Meniscotherium at the head of the north branch of Oso Arroyo, northeast of Lindrith, New Mexico.

SIMPSON, G. G., 1948b.
The Eocene of the San Juan Basin, New Mexico.
Amer. Jour. Sci. 246: 257-282 (Part 1), 363-385 (part 2),
5 Figures.

Author's Abstract

Discovery of Eocene mammals in the San Juan Basin by Cope in 1874 and subsequent collecting of these faunas are reviewed, as well as the broader outlines of early Cenozoic stratigraphic studies here from Newberry, 1859, to the present time. A review of the stratigraphic nomenclature leads to the conclusion that a Paleocene Nacimiento formation, with the Puerco and Torrejon faunas (not formations), is recognizable but that the overlying formation, commonly but incorrectly called "Wasatch," has had no acceptable name. The new name San Jose formation is proposed for the "Wasatch" of authors in the San Juan Basin. The lithology of the formation in its type region, along the eastern margin of the basin, is discussed and three measured sections are given. In this region the San Jose is preceded by a hiatus representing late Paleocene time. There was gentle regional uplift and probably stronger folding outside the present basin between the deposition of the Nacimiento and that of the San Jose, but the strong uplift that now defines the eastern margin of the basin is post-San Jose. In southern Colorado there was nearly continuous deposition through the later Paleocene into the Eocene. In the type region, the San Jose has two distinct clay facies and these contain mammalian faunas also recognizably different in facies. These faunas are all Wasatchian and probably extend over the early and middle parts of that age, rather than the middle and later parts as commonly supposed. The Tiffany fauna of southern Colorado, well known to be of late Paleocene age, is in beds not now separated from the San Jose but robably separable and only tentatively assigned to that formation.

SIMPSON, G. G., 1950a.
Lower Tertiary formations and vertebrate faunas of the San Juan Basin.
New Mexico Geol. Soc. Guidebook, 1st Field Conf.:85-89.

This paper is a general discussion of the history of fossil vertebrate collecting in the San Juan Basin and the relationship of the fossils to the Tertiary stratigraphy of the area. Simpson mentioned that extensive faunal lists are conveniently available in the literature and, therefore, were not given in this paper.

SIMPSON, G. G., 1950b.
Cenozoic formations and vertebrate faunas.
Soc. Vert. Paleont. Guidebook, 4th Field Conf.:74-85.

This article includes a brief overview of the stratigraphy and paleontology of the lower Tertiary rocks of the San Juan Basin.

SIMPSON, G. G., 1950c.
Lower Tertiary formations and vertebrate faunas of the San Juan Basin.
New Mexico Geol. Soc. Guidebook, 1st Field Conf.:85-89.

This article is a reprint of part of Simpson (1950a) with minor changes and a more extensive discussion.

SIMPSON, G. G., 1951.
Hayden, Cope and the Eocene of New Mexico.
Acad. Nat. Sci. Phila. Proc. 103:1-21. 5 Plates.

This paper, mostly a narrative, cites the background and some general contributions to geology and paleontology by Hayden and Cope. It presents an historical account of Cope's work in the San Juan Basin of New Mexico and the events leading to it in some detail. One of the purposes of this paper was to locate as accurately as possible the sites that Cope collected. His journal was frequently quoted in establishing these locations.

SIMPSON, G. G., 1954.
An Apatemyid from the early Eocene of New Mexico.
Amer. Mus. Novitates 1654:1-4. 1 Figure.

The status of the family Apatemyidae was briefly given and a new species from the Almagre facies of the San Jose Formation of the San Juan Basin described. Only the type of this new taxa, Teilhardella whitakeri, has thus far been discovered (type specimen - AMNH No. 48004, partial lower left jaw with P_4-M_1). A brief diagnosis and modest comparisons were given for this type.

SIMPSON, G. G., 1955.
The Phenacolemuridae, new family of early primates.
Amer. Mus. Nat. Hist. Bull. 105:411-442.

Phenacolemur jepseni (n. sp.) was named from a skull found in the Regina Member of the San Jose formation in Arroyo Blanco (Simpson's "Quarry 88").

SIMPSON, G. G., 1959.
Fossil mammals from the type area of the Puerco and Nacimiento strata, Paleocene of New Mexico.
Amer. Mus. Novitates 1957:1-22. 6 Figures, 4 Tables.

This paper briefly discusses the significance of Paleocene mammals from the San Juan Basin of New Mexico and the early paleontological work done in the Basin. A number of American Museum localities in the Nacimiento Formation and their contained fossils were given. Most of these localities are from the Cuba region.

SIMPSON, G. G., 1960.
Late Cretaceous and early Cenozoic in the San Juan Basin.
New Mexico Geol. Soc. Guidebook 11th Field Conf.:75-77. 1 Figure.

The importance of a continuous depositional sequence from latest Mesozoic to earliest Cenozoic time was related in this paper. Fossils recovered from these beds were not specifically identified but were considered in general terms. Their importance as stratigraphic tools was emphasized. Information concerning nomenclatural changes of fossil-bearing units was also given.

SIMPSON, G. G., 1964.
Species density of North American Recent mammals.
Syst. Zool. 13:57-73. 5 Figures.

From Author's Introduction

This study deals with species density, that is, with the numbers of species present in different parts of the continent, the over-all pattern formed from those varying densities, and possible factors influencing the pattern.

SIMPSON, J. H., 1850.
Journal of a military reconnaissance from Santa Fe, New Mexico to the Navajo Country.
In Rept. Sec. War with Reconn. of Hes. from San Antonio to El Paso, Johnson and others, 31st Cong., 1st Session, Senat Ex. Doc. 64:146-148.

This was the first report of coal and petrified wood in the San Juan Basin. These were observed by Simpson in 1849 along the Rio Puerco north of Cabezon and at several localities farther west in northwestern New Mexico.

SINCLAIR, W. J., 1914.
"Laramie?" Puerco and Torrejon in the San Juan Basin, New Mexico.
Geol. Soc. Amer. Bull. 25:138. No illus.

Author's Abstract

Near Ojo Alamo, New Mexico, a continuous section through the so-called "Laramie" and the overlying Puerco and Torrejon formations is exposed. Fossils are abundant and the stratigraphic relations of the beds absolutely diagrammatic. It will be shown that dinosaurs, which are abundant in the Ojo Alamo beds ("Laramie" of the United States Geological Survey), are not found above the marked erosional unconformity which separates the Puerco clays from an underlying heavy conglomeratic sandstone with many volcanic pebbles and much fossil wood. This unconformity may be traced for many miles about the southern margin of the San Juan Basin and may represent an important time hiatus. The position of the various faunal levels of the Puerco and Torrejon will also be discussed, and measured sections will be presented showing their position with reference to the unconformity below the Puerco, above which dinosaurs are not found.

SINCLAIR, W. J. AND W. GRANGER, 1914.
Paleocene deposits of the San Juan Basin, New Mexico.
Amer. Mus. Nat. Hist. Bull. 33:297-316. 2 Figures, 8 Plates.

This is a stratigraphic paper describing the Cretaceous Ojo Alamo Formation and the Paleocene Puerco and Torrejon formations. These formations are south and west of Canyon Blanco. "Nacimiento" was considered to be of group rank, containing the last two formations. The paleontology of these three formations was mentioned in general terms.

SMITH, C. T., V. C. KELLEY, E. H. BALTZ, JR., AND R. A. BAILEY, 1968.
Road log from Albuquerque to Farmington.
New Mexico Geol. Soc. Guidebook, 19th Field Conf.:193-201.
No illus.

This road log, while primarily directed towards the geology between Albuquerque and Farmington, New Mexico, does mention some sites of fossil recovery. A brief history of the Paleocene fossil vertebrate discoveries in the Nacimiento Formation near Cuba, especially those of Simpson, were recounted.

STANTON, T. W., 1916.
Nonmarine Cretaceous invertebrates of the San Juan Basin.
U.S. Geol. Surv. Prof. Paper 98:309-326. 5 Plates.

This paper includes a description of 25 species of bivalaves and gastropods collected mostly from the Fruitland Formation, and two species of bivalves from the Kirtland Shale. The fossils were collected within the San Juan Basin in New Mexico and Colorado, mostly near Fruitland and Jewett, New Mexico. Several sites south of the San Juan River and east of the Chaco River in New Mexico have yielded similar fossils.

TSCHUDY, R. H., 1973.
The Gasbuggy Core--a palynological appraisal.
Four Corners Geol. Soc. Mem.:131-143.

The bore hole GB-1 in Sec. 36, T29N, R4W, Rio Arriba County was cored to obtain samples of laboratory analysis of rocks to be affected by the nuclear blast.

The pollen assemblages present in samples above 3714 feet are indicative of an early Tertiary Age. Below this, specimens of the genus Protoeacidites, a late Cretaceous index fossil in the Rocky Mountain region, were present. Comparisons were made between the Judith River Formation of Montana, the Teapot Sandstone Member of the Mesaverde Formation of Wyoming, and the Raton and Vermejo formations of New Mexico.

THORPE, M. R., 1934.
Meniscotherium robustum sp. nov. and a discussion of Hyracops socialis Marsh.
Amer. Jour. Sci. 5th Ser. 27:401-409.

Meniscotherium robustum (n. sp.) was named for a skull collected by David Baldwin in the San Jose Formation.

VAN HOUTEN, F. B., 1945.
Review of Latest Paleocene and Early Eocene mammalian faunas.
Jour. Paleont. 19(5):421-461.

A review of all of the latest Paleocene (Clarkforkian) and Early Eocene (Wasatchian) mammalian faunas from the Rocky Mountain intermontane basins was given. Comparison of the faunas was made, with a section discussing parts of the San Juan Basin.

The Largo fauna was secured from the upper 350 feet of the Canyon Largo formation at the head of Largo Arroyo and in the area west and southwest of Ojo San Jose drained by the Puerco River tributaries. Meniscotherium is especially common in these beds. Meniscotherium tapiacitis and M. chamense terraerubrae, as well as Ambloctonus sinosus and A. hyaenoides, are diagnostic.

WIELAND, G. R., 1928.
Associate in Paleontology, Report on cycadeoids.
Carnegie Inst. Washington Yearbook 27:390-391.

Wieland discussed his collecting of cycadeoids from the Chuska Mountains of the San Juan Basin, New Mexico. He referred many of these specimens to his proposed genus Navojoia which was later changed to Monanthesia.

WIELAND, G. R., 1930.
Researches in paleobotany: the Mesa Verde cycadeoids.
Carnegie Inst. Washington Yearbook 29:243-247.

The second season of field exploration in the San Juan Basin of New Mexico was discussed. It resulted in a doubling of the petrified

cycad collection from the Mesa Verde. As the trunks had eroded out, many were crushed and flattened. Wieland postulated on the concept of the evolution of Cycadeoidea and early angiosperms. He mentioned the locality for the cycadeoids and petrified woods as in the Chuska Mountains about 25 miles north of Gallup, New Mexico.

WIELAND, G. R., 1934.
Fossil cycads, with special reference to Raumeria reichenbachiana. Geopport sp. of the Zwinger of Dresden.
Palaeontographica 79B:85-130.

This report is a general discussion of cycadeoids and their anatomy. In discussing their distribution, Wieland reported Monanthesia blanca and M. magnifica from the Mesa Verde Formation of the San Juan Basin, New Mexico. He mentioned the small "flowered" types of the closing Cretaceous as so well exemplified by collections from the San Juan country. He stated that the actual "stamens" are not seen, but the bundles indicate a disk of ten small and "reduced stamens." Monanthesia blanca was considered a new species with "flower" stalks in all leaf base axils. A tangential section of Monanthesia magnifica was illustrated.

WIELAND, G. R., 1936.
Cycadeoid investigations and field work.
Carnegie Inst. Washington Yearbook 35:333-340.

Wieland discussed the evolution of cycadeoids and their possible ancestry. He reported Monanthesia blanca and a new species called M. aequalis from the Mesa Verde Formation. He further reported a specimen of Tempskya, a palm frond and a palm axis from the vicinity of the old "Mexican Springs" trading station, New Mexico. He stated that the Mesa Verde includes the most remarkable series of petrified types of any single western horizon. These include five groups of plants, the conifers, dicots, cycadeoids, palms and true ferns, which are silicified.

WIELAND, G. R., 1941.
The Carpathian-Black Hills cycadeoid parallel.
Amer. Jour. Sci. 239:523-532. 6 Plates.

The author compared the cycadeoids of Italy and South Dakota. He also included a discussion of specimens of the cycadeoid Monanthesia from the Upper Cretaceous of the San Juan Basin of New Mexico.

WIELAND, G., 1942.
Cycadeoid types of the Kansas Cretaceous.
Amer. Jour. Sci. 240:192-203. 2 Figures, 11 Plates.

The author discussed the cycadeoids from the Niobrara Chalk Formation of Kansas and related them to specimens collected from the San Juan Basin of New Mexico. "These are the near and true relatives of the Monanthesia niobrarense which in truth may likewise come from those same forested bayou lands to the west of the Niobrara sea, with their varied conifers, cycadeoids, palms, lauraceous dicots, and dinosaurs."

WILSON, R. W., 1949.
Preliminary report on a Torrejonian faunule from near Angels Peak, San Juan Basin, New Mexico.
Geol. Soc. Amer. Bull. 60 (pt. 4):1930-1931. No illus.

Author's Abstract

In 1916, Walter Granger obtained a fragmentary mammalian fauna of Torrejonian age from the Nacimiento formation as exposed near Angels Peak in the San Juan Basin of New Mexico. Only a few genera were identified, and the fossils were found scattered through several hundred feet of the section. Recently, the University of Kansas recovered about 145 determinable specimens from a locality in the same area. Considerable importance is attached to the present collection because it is not only more diverse than that obtained previously, but also because it was obtained from a single stratigraphic level in a geographic area so small as to approach quarry conditions. Our collection was made approximately at the upper limit stratigraphically of the fossiliferous beds searched by Granger.

The faunule demonstrates clearly the Torrejonian age of the level concerned, but its exact position in time has not been determined. Certain characteristics suggest a slightly different age or, less likely, a slightly different facies, than the collections made farther south and southeast in the better-known sections of the Nacimiento. For example, in respect to size, many of our specimens are close to or below the minimum recorded for those of comparable species obtained elsewhere in the basin.

The faunule consists of approximately: Arctocyonidae, 33 per cent; Hyopsodontidae, 21 percent; Phenacodontidae, 18 per cent; Periptychidae, 15 per cent; Miacidae, 4 per cent; and others 9 per cent. A generic list of mammals follows:

Ptilodontid	Claenodon?	Mioclaenus
Palaeoryctes	Tricentes?	Ellipsodon
Pentacodon	Chriacus	Protoselene
Indrodon	Deltatherium	Tetraclaenodon
Primates?	Triisodon?	Coriphagus
Conoryctine?	Goniacodon	Anisonchus
Psittacotherium?	Didymictis	Periptychus

WILSON, R. W., 1950.
Supposed primates from the Torrejon fauna of the Nacimiento Formation. Geol. Soc. Amer. Bull. 61:1515-1516.

Specimens with primate-like aspects were obtained from the Nacimiento Formation as exposed in Kutz Canyon drainage a few miles west of Angels Peak. They were tentatively regarded as anaptomorphids, close to members of the Paromomyinae.

WILSON, R. W., 1951.
Preliminary survey of a Paleocene faunule from the Angel's Peak area, New Mexico.
Univ. Kans. Mus. Nat. Hist. Publ. 5:1-11. 1 Figure.

A brief history of discovery was given for the presently listed specimens from the Angel's Peak area of the San Juan Basin. The reported fossils, approximately 150 specimens, were collected in a three to four foot bed of reddish silt in the NW 1/4 of sec. 14, T27N, R11W, San Juan County, New Mexico. 25 species or higher taxonomic ranks of mammals were identified.

WILSON, R. W., 1956a
A new multituberculate from the Paleocene Torrejon fauna of New Mexico.
Kans. Acad. Sci. Trans. 59:76-84. 1 Figure, 1 Table.

The new multituberculate described in this paper is a species questionably assigned to the genus Ectypodus, E. macrotomaus (type specimen - KU No. 7908, right lower jaw with P_3-M_2). It was collected at the head of Kimbetoh Arroyo, San Juan County, New Mexico (NW 1/4 sec. 2, T23N, R9W). This new species was figured, described and compared with related forms at modest length. Also included in this paper are faunal lists for three New Mexico faunules of Torrejonian localities of the University of Kansas (NW 1/4 sec. 14, T27N, R11W, San Juan Co., NW 1/4 sec. 2, T23N, R9W, San Juan Co., and SW 1/4 sec. 20, T22N, R6W, Sandoval Co.).

WILSON, R. W., 1956b.
The condylarth genus Ellipsodon.
Kans. Univ. Mus. Nat. Hist. Publ. 9(5):105-116.

The author described the known species of Ellipsodon, explaining the problems associated with various species. The type species of Ellipsodon, E. inaequidens, was collected by D. Baldwin (for E. D. Cope) at Gallegos Canyon (northern San Juan Basin). E.? inaequidens was also collected

from Bohannon Canyon. A new species, E. grangeri was described from Kutz Canyon and from Kimbetoh Arroyo. All of these specimens are from the Nacimiento Formation.

Some species of Ellipsodon are referred to Promioclaenus.

WILSON, R. W., 1956c.
Additional remains of the multituberculate genus Eucosmodon.
Kans. Univ. Mus. Nat. Hist. Publ. 9(6):117-123.

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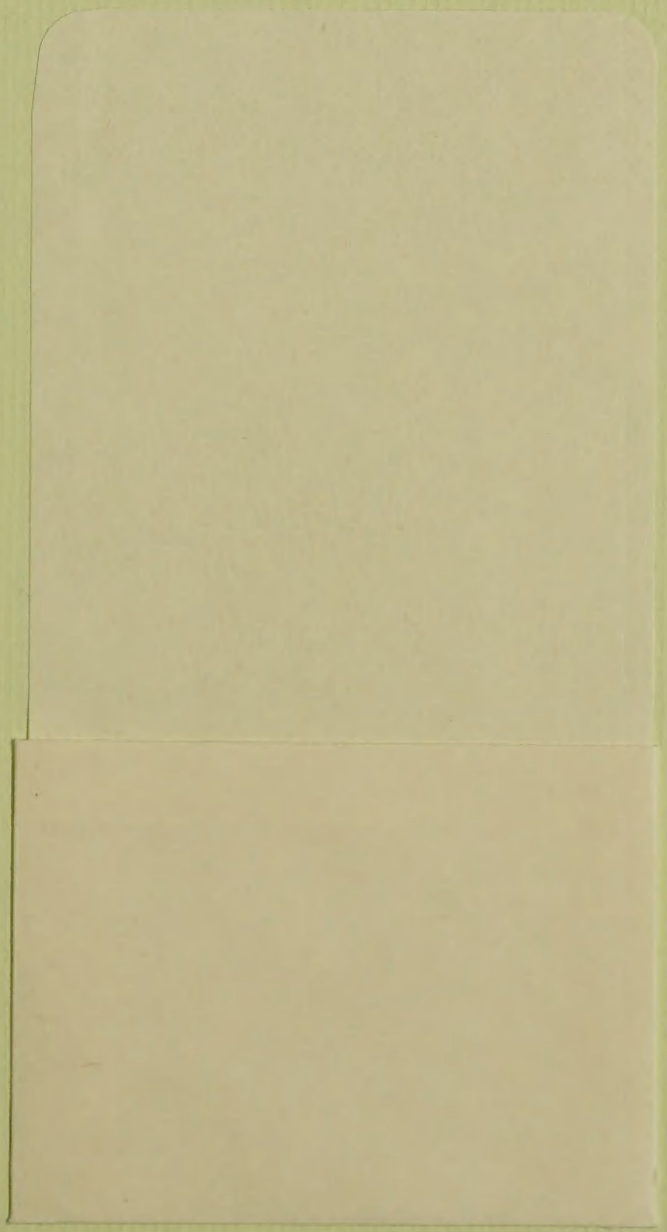
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